A SHORT-TERM MACROECONOMETRIC MODEL FOR AN OPEN AGRARIAN ECONOMY: NEPAL

BY

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To my dear uncle, Bhuvan Man Singh,
for his enduring love and inspiration.

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ABBREVIATIONS USED

AJAE	American Journal of Agricultural Economics
GDP	Gross Domestic Product
HMG	His Majesty's Government, Nepal
IMF	International Monetary Fund, Washington
NBER	National Bureau of Economic Research
NPC	National Planning Commission, HMG, Nepal
NRB	Nepal Rastra Bank, Kathmandu
3SLS	Three Stage Least Square
2SLS	Two Stage Least Square
OLS	Ordinary Least Square
PGDP	GDP Deflator
UN	United Nations

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While the major concern of most literature on the economics of less developed countries has centered around long-term economic growth, policy makers are now more concerned than ever with short-term issues and related problems in economic stabilization. The traditional demand-related shocks, and the increasing incidence of supply-induced shocks (related to trade, finance, exchange rates, etc.) are reasons for this change in emphasis.

Very little research based on a macro framework has been done in Nepal. This study addresses this lacuna with a short-term structural model of the economy. The model takes cognizance of the importance of the agricultural sector, trade, and government and attempts to quantitatively assess the effect of some general economic policies such as the exchange rate, government budgetary deficit, and foreign aid on the agricultural sector and the rest of the economy.

The model was estimated with truncated two stage least squares. Multipliers were derived for selected exogenous variables with respect to endogenous variables such as agricultural exports, fertililzer use, government budgetary deficit, foreign aid, and the import tax. An increase in agricultural exports of Rs 1 million was estimated to increase GDP by Rs 1.06 million, nonagricultural GDP by Rs 0.62 million, total consumption by Rs 0.06 million, and total tax revenue by Rs 0.03 million. The estimated elasticities of total tax revenue with respect to the import tax rate and the direct tax rate were to be 0.169 and 0.268, respectively. The estimated elasticity of total imports with respect to the import tax rate was 0.291. An increase of Rs 1 million in government budgetary deficit was estimated to increase the money supply by Rs 0.838 million. An increase of Rs 1 million in foreign aid was estimated to effect an increase of Rs 0.550 million in money supply. The model tracked the course of the Nepalese economy reasonably well for the period of study (1964-65 to 1980-81).

CHAPTER I
INTRODUCTION

Statement of the Problem

The major concern of most literature on the economics of less developed countries has centered around long-term economic growth. Indeed, long-term growth has been the major preoccupation of the developing countries, most of which have embarked upon the course of planned economic development. However, even the staunchest advocates of supply-oriented capital-and-foreign-exchange constrained analysis of LDCs seem to be having second thoughts about the importance of short-run factors and stabilization problems [Behrman, 1974:422].

The need to treat short-run features (e.g., price response, capacity utilization determination, aggregate-demand-related policies) has not received adequate attention. Taking stock of extensive research undertaken of long-term quantity-theoretic models about India, Bhagwati and Chakrabarty [1969:2] observe that

> Unfortunately, there has been no serious attempt so far at building a relevent short-term model for the Indian economy which would permit the policy-makers to take informed decisions--a lacuna which became only too obvious when the recent industrial recession in 1967 left the policy-makers in a position where action had to be taken without any systematic knowledge of key relationships (such as the effect of corporate taxes on savings, pricing policies of corporations, etc.).

Clearly, it has not been the tradition in the existing literature on developing countries to give any significant concern to short-run

issues and the related aspects of stabilization policies. Short-run issues are often regarded as of concern only for the developed countries.

Economic Stabilization in Less Developed Countries

In the context of the developing countries, the past decade has seen much of shocks, both demand-induced and supply-related in agriculture (including its transformation), technological progress, changes in world trade and payment situations, including recessions in the industrial countries. It may not be an exaggeration to regard such shocks, not as exceptions, but rather more general features. Indeed, for an economy like the Nepalese, this has greater applicability not only on account of regularly occurring internal shocks, e.g., uncertain agriculture due to excessive dependence on the variable monsoons and changing economic and institutional structures, but also frequent external shocks, by way of trade and finance.

Economic stabilization in developing countries is commonly addressed to two common issues: (1) excessive or unsustainable balance of payments deficits, and (2) the high rate of domestic inflation [Cline and Weintraub, 1981; Khan and Knight, 1981].

In the 1970s, economic stabilization became a central policy issue for many developing countries and for the international agencies alike because worldwide inflation and the balance-of-payments pressures associated with higher oil prices affected developing (and developed) countries in all regions [Cline and Weintraub, 1981:1]. The question of how stabilization policies affect economic development has been a

subject of controversy since the monetarist/structuralist debate of the 1950s and 1960s. In general,

> The "monetarist" view has been that inflation and attendant balance-of-payments difficulties are usually caused by allowing aggregate demand to run ahead of supply and that stabilization can be approached, therefore, only within a framework in which demand is restrained within an economy's supply capacity. Structualists, on the other hand, contend that rigidities in the pattern of production and demand typically prevent monetary restraint from being smoothly reflected in a moderation of inflationary pressures and a redirection of resources toward the external sector. [Crockett, 1981:54]

In this view, in the short run, demand restraint is reflected mainly in a drop in domestic output; this drop, in turn, helps to discourage investment, reducing the economy's capacity to improve production and exports in order to earn foreign exchange. This would imply that economic policy should focus on removing supply bottlenecks and related structural rigidities. This would, in turn, enable us to have increased overall output capacity. This is, according to the "structural" macroeconomists,[1] the way excess demand could be reduced and resources generated for improving balance-of-payments with less, otherwise concommitant, need to cut domestic absorption. Essentially, according to the "structuralists," economic policy should focus upon removing supply bottlenecks and other structural rigidities so that output capacity could be raised.

An important conclusion of the Brookings Conference on Economic Stabilization in Developing Countries [Cline and Weintraub, 1981] is that "the last decade has witnessed an increasing recognition of the role of the supply side in the design of stabilization programs"

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[1] In close vein with Lance Taylor who calls this related field "structural macroeconomics," see his book, Structural Macroeconomics.

[Crockett, 1981:56]. Ultimately, policy-makers have to ensure that domestic absorption (or the growth of real demand) is limited within the capacity of the economy to produce real goods domestically and/or attract voluntary savings from abroad regardless of the efficiency of the pattern of production and demand in the economy.

The question of how to deal with the issues of stabilization, primarily on account of inflation and balance-of-payments difficulties, raises several policy issues at both international and national levels. There is a growing controversy whether these observed instabilities, related to inflation and balance of payment difficulties, have their domestic origin or are due to external reasons.[2] Along with several similar works, one analyst maintained that external factors, especially deteriorating terms of trade and recession in industrial country markets, had been primarily responsible for stabilization problems in developing countries in the 1970s and that stabilization programs under international auspices should accordingly increase the amount and flexibility of balance-of-payments support [Dell and Lawrence, 1980]. In a paper in the "Brookings Papers on Stabilization,"[3] Stanley Black, applying discriminant analysis, concludes

> . . . that both internal and external factors caused heightened economic instability in the 1970s, but that the role of external factors was more limited than asserted by some analysts who attributed most instability to external factors and, consequently, advocated major expansion in international financing facilities, softening of their conditionality, and special need to restructure the world trade and payment arrangements. [1981:70]

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[2]This is an important issue since it has major implications regarding how to deal with the problem of instability.

[3]Cline and Weintraub, "Economic Stabilization in Developing Countries," NBER, 1981.

In this connection, Black's [1981] study demonstrates that monetary disturbances from abroad were transmitted through increased developing country reserves and induced domestic monetary expansion in the early 1970s. It is emphasized, however, that the main source of instability was the internal source--extensive monetary expansion mainly reinforced by "assymetrical sterilization policy" involving non-sterilization of reserves inflows but sterilization of outflows, i.e.,

> increased reserves were not offset by restrictive monetary policy, but decreased reserves were offset by expansionary monetary policies that kept reserve contraction from reducing the monetary supply. [Cline and Weintraub, 1981:9]

Short-term Macroeconometric Model and the Nepalese Economy

In spite of the importance of short-term issues for developing countries like Nepal, there are few analytical frameworks, based upon macro models, to quantitatively analyze short-run phenomena. Nor is there guidance, grounded on sound theoretical and empirical bases, available to the policy-makers from an overall perspective of the economy. More specifically, of particular interest to them would be (1) the repercussions of a particular shock on the economy, or a particular sector of it, and (2) the short-run adjustments that need to be undertaken for stabilization (including stabilization along a long-run path).

There is a dearth of macroeconomic[4] frameworks/models which capture the effects of economic policies across sectors or the

[4] The "Macro" qualifier means that the models are aggregated with only a few sectors, and the focus is on interactions among major groups of actors in the economy.

general economy. Therefore, it is characteristic in Nepal for different government agencies to take a narrow and parochial view of events and policies, within their respective sectors without concern for possible interrelationship among sectors. For example, the Agricultural Ministry is often hardly interested in general economic policies which they would consider quite outside their interest, although these policies could have important repercussions on the agricultural sector itself. As a consequence, policy interests are limited to internal issues such as agricultural extension, agricultural credit, input subsidies, etc., which fall directly within the administrative jurisdiction of the Agricultural Ministry. It is not uncommon to find that the extension service is regarded as the sole answer to agricultural modernization. Efforts of agricultural policy-makers to make headway in getting agriculture moving are frustrated when the macro sector is sending contrary signals [Timmer et al., 1983]. General economic policies, such as those affecting price, trade, and commerce do have wide effects on the agricultural sector through urban-rural terms of trade. In the context of discussing food policy, Timmer et al. [1983:215] emphasizes that ". . . macroeconomic forces are too pervasive and too powerful for micro sectoral strategies to overcome." A general macroeconomic model of the Nepalese economy is needed to better understand what would be the impact on a particular sector, such as agriculture,

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Most studies available on the Nepalese economy are sectoral and impact studies of development programs and development strategies. There are a number of good studies available on the structure of the general kind without much use of modern analytical techniques.

of a change in fiscal, monetary and trade, or foreign commercial policies.

Also, in the Nepalese context, any discussion of the economy involves the agricultural sector in an essential way. Agriculture contributes heavily to the economy--more than 90% of the population depend upon agriculture, over 65% of GDP originates in the agricultural sector, and about three fourths of exports comes from this sector. Indeed, the unsatisfactory performance of agriculture is singly identified as the main reason that the economy has until recently failed to achieve planned growth targets in spite of over-fulfilling expenditure targets in the Plans [National Planning Commission, Sixth Plan, 1980]. Therefore, it is only logical that any macroeconomic model for the Nepalese economy should at least include adequate treatment of the agricultural sector so that one could examine the effects of alternative policy proposals with special emphasis on increasing agricultural production and income. As a consequence, the present study has been geared toward the investigation of the interaction of the nonagricultural sector with the agricultural sector.

The Nepalese economy is also characterized as a "small open economy," (SOE)[6] and trade is an important sector. The ratio of the

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[6]"SOE" is "any country (or other political jurisdiction of, for that matter) that treats the price of any international trade commodity or asset as exogenously determined and attempts to maximize some objective function with this constraint in mind" [Prachowny, 1975:1]. The term "small" refers to the fact that in relation to total world availability of any traded good or asset, the "small open economy" provides only a miniscule fraction. The term "open" implies, on the other hand, that the tradeable sector plays an important role in the structure of the economy. In a sense, the "SOE" is analogous to a firm in perfect competition that also attempts to maximize an objective function subject to the constraint of given commodity and factor prices [Prachowny, 1975:1]. To a large extent, this may be an appropriate description of the Nepalese economy.

volume of trade to GDP runs as high as 20 percent. The smallness of the domestic market means that deliberate public policy to step up exports is required for production to reach an efficient scale. As the development efforts proceed, imports are expected to rise significantly because of increased income and need for large imports of capital and intermediate goods required for investment.

While the focal interest of the present study lies in the short-term issues raised in the foregoing sections, in the Nepalese context it is important to recognize that two principal aspects of the economy, agriculture and trade, need to be adequately reflected if any macro-economic model built is to have realistic bearing on the Nepalese economy.

Scope, Objectives, and Importance of the Study

Scope of the Study

The foregoing discussions highlight the interrelatedness of stabilization, agriculture, and trade. Given the existing structure of the economy and the policy perspective, they are of utmost importance to the Nepalese economy. Against this backdrop, the guiding premises for the present study were set as the following:

The first premise is that agriculture is the principal sector of the Nepalese economy, and inherently, the problems related with the economy's instability can often be traced to the performance of the agricultural sector.

It will be the principal endeavor of the present study to examine and quantify the relationship between the agricultural sector and the

rest of the economy within the framework of the short-term macro-economic behavior of the Nepalese economy.

The second premise is that the Nepalese economy basically exhibits the characteristics of "small open economy" with high dependence of the economy on trade, which provides a great extent of dynamism to the economy. The present study seeks to understand and make quantitative analysis of the relationship between the general economy and the agricultural sector as well as trade.

However, an issue of concern throughout the study is related to stabilization.[7] This issue justifies building a short-term macro-econometric model of the Nepalese economy.

The Nepalese economy is often subjected in significant ways to large and continual shocks, not only domestic but also external. Domestically, the nature of existing uncertain agriculture, largely dependent on the unpredictable monsoons and other changing structural features, often exhibit the greatest potential incidence of shocks to the economy. The fact that the country is small and very much dependent upon trade[8] and foreign aid greatly extends the potential source of shocks to the economy.

From the foregoing perspectives, the following working hypotheses were derived:

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[7] It is, indeed, very common to find "stability" prominently reflected in official policy pronouncements of Government, especially in the Yearly Government Budgets. (See Annual Budget Speeches, Finance, Ministry, HMG/Nepal for pointed references about the Budget's being mainly aimed at fostering stability in the national economy.)

[8] This problem is further compounded by transit problems. Most of the shipments of exports and imports have to go through India, as Nepal is landlocked.

1. The level and changes in the national output/income in the Nepalese economy are crucially linked with the fluctuations in the agricultural sector and the foreign sector, principally trade, and

2. The problem of economic stabilization is an important issue for the Nepalese economy in general and the agricultural sector in particular.

These hypotheses will underlie the specification of the present model. The choice of variables and their functional relationships is guided basically by the concern with the short-run behavior of the economy.

Objectives of the Study

The principal objectives of the present study are (1) to build a short-term structural model for the Nepalese economy; (2) to examine the foreign sectors with the rest of the economy, as an aspect of the short-term features of the economy; and (3) to attempt a quantitative assessment of the effect of some general economic policies on agriculture and trade.

Importance of the Study

Most available literature on the Nepalese economy relates mainly to the explanation of the long-term growth of the economy, often limited to the simple description of the structure of the economy. Clearly, there is a general lacuna in the greater use of empirical tools for planning and evaluation of economic policies, especially relating to the short-term aspects of the Nepalese economy. The present study hopes to partially fulfill this lacuna. In particular,

the study could alleviate the need for useable macro models in the design and evaluation of public economic policy.

The study is intended to further the existing understanding of some of the quantitative dimensions of the structural features and stabilization issues of the Nepalese economy. Of particular concern would be the examination of the sectoral behavior from the perspective of the general economy. This should certainly help shed light on how a particular economic policy affects different sectors of the economy--i.e., going beyond the "micro" focus in economic policies.

Data

The present study has been mainly based upon data published by various national and international agencies. Several issues of Agricultural Statistics of Nepal [Ministry of Food and Agriculture, HMG/Nepal, 1972, 1977, 1978] contain most of the data on agriculture and related sectors. The Quarterly Economic Bulletin (Nepal Rastra Bank, Nepal) regularly publishes data on the financial, monetary, and trade situation of Nepal, including the budgetary situation of the government. Extensive data are also available in World Tables [World Bank, 1976, 1979, 1980], and regularly in the Statistial Yearbook of Asia and the Pacific (ESCAP, UN), the FAO Trade Yearbook (FAO, UN), the FAO Production Yearbook (FAO, UN), and the International Financial Statistics (IMF, Washington), including its special issues on prices. They are the principal sources of data in the present study.

International agencies (e.g., FAO, IMF, World Bank) cross check before publishing data from national sources. Therefore, wherever

possible, data from such sources were used. The period of study of the present study was 1964-65 to 1980-81.

CHAPTER II
OVERVIEW OF THE NEPALESE ECONOMY

Serious efforts toward economic development in Nepal did not start until the advent of democracy and with the launching of the First Five Year Plan in 1956-57.[1] The major efforts of the first three plans (1956-57 to 1969-70) were basically addressed to creating economic infrastructures which were to lay the foundation for future expansion of the directly productive sectors.

During the 1965-1975 period, the decade spanning Nepal's third and fourth plans, real GDP growth averaged 2.0% per annum. Population growth was 2.1% per annum, as shown in Table 1. These growth rates imply a net reduction of about 1% in per capita GDP over the period [Sixth Plan, NPC]. During the Fifth Plan period (1975-76 to 1979-80), population growth was 2.3%, and real GDP great at 2.2% per annum, compared with the planned target of 4% [Sixth Plan, NPC].

Clearly, over the decade 1961-1971, population grew at 2.07%. This growth has increased to 2.65% in the following decade. The population is currently at 15.02 million in 1981. According to the latest available census, in 1971, 94% of the economically active population is engaged in agriculture.

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[1]First Plan, 1956-57 to 1961-62; Second Plan, 1962-63 to 1964-65; Third Plan, 1964-65 to 1969-70; Fourth Plan, 1970-71 to 1974-75; Fifth Plan, 1975-76 to 1979-80; Sixth Plan, 1980-81 to 1984-85.

Table 1. Growth of population in Nepal

Year	Population (in millions)	Period	Annual compound rate of growth
1961	9.42	1961-1971	2.07%
1971	11.56	1971-1976	2.12%
1976	12.82	1976-1981	3.19%
1981	15.02	1971-1981	2.65%

SOURCE: National Planning Commission [1980].

Table 2 gives the breakdown of GDP by sectors. Agriculture has remained the dominant sector, comprising about 65% of GDP over the years. The share of manufacturing has remained small but has increased to 4.12% of GDP in 1976-77. The share of cottage industry has remained at about 6.5% over the years.

Table 3 shows shares of GDP for the agricultural and the nonagricultural sectors. The share of agriculture remained high at 65.27% and 69.7%, respectively, at the beginning and the end of the decade (1964-65 to 1974-75). It has come down to 54.3% in 1979-80. Over the entire period of the Fifth Plan (1975-76 to 1979-80), agriculture comprised 61% of GDP [Sixth Plan, NPC].

Savings were only 3.2% of GDP in 1970-71 and increased steadily to 7.4% in 1979-80 (Table 4). The rate of investment similarly rose from 6.5% in 1970-71 to 13.5% in 1979-80. Savings as a percentage of investment increased from 49.2% in 1970-71 to 55.2% in 1979-80. The savings gap (between investment and savings) has remained significant in the economy.

Data in Table 5 show the phenomenal growth of imports over the last 15 years. Of particular concern to policy-makers is the ever widening trade deficit. The deficit as percentage of total exports has risen from 85.8% in 1964-65 to 104.0% in 1974-75 and 202.4% in 1979-80. This means that the deficit is presently twice the size of exports, certainly a matter of grave concern for the economy. It could be also seen that the total trade stands at about 20% of GDP and so remains significant to the overall economy.

One of the distinguishing structural features of the Nepalese trade is that trade is highly concentrated, both in terms of

Table 2. Structure of GDP

Source	1964-65		1976-77	
	Value added	% share	Value added	% share
	million rupees			
Agriculture	3654	(65.2)	10811	(62.3)
Mining	1	---	7	---
Manufacturing	83	(1.5)	716	(4.12)
Construction	123	(2.2)	289	(1.66)
Transport Communication	91	(1.6)	1201	(6.92)
Cottage Industry	365	(6.5)	1081	(6.23)
Financial Institutions	69	(1.2)	277	(1.59)
Ownership of Dwelling	654	(11.7)	849	(4.89)
Electricity	4	---	45	---
Wholesale-Retail Trade	306	(5.5)	850	(4.90)
Services	170	(3.0)	824	(4.75)

SOURCE: Ministry of Food and Agriculture, HMG [1978]; UN [1980a].

Table 3. Percentage shares of agriculture and nonagriculture in total GDP

Sectors	1964-65	1974-75	1979-80	Fifth Plan period
Agriculture	65.27	69.7	54.3	61.1
Nonagriculture	34.73	30.3	45.7	39.9

SOURCE: Ministry of Food and Agriculture, HMG [1978]; National Planning Commission [1980].

Table 4. Investment and savings

	Investment	Savings	Savings as % of investment
	million rupees		
1970-71	589.0 (6.5)	290.0 (3.2)	49.2%
1974-75	1538.8 (9.3)	798.3 (4.8)	51.9%
1979-80	3215.6 (13.5)	1774.2 (7.4)	55.2%
Fifth Plan*	(12.6)	(8.2)	65.2%

* Fifth Plan period is 1974-75 to 1979-80. Numbers within parenthesis represent percentages.

SOURCES: World Bank [1980]; National Planning Commission [1980].

Table 5. Volume of trade

	Total exports	Total imports	Total deficit	Deficit as % of exports	Trade as % of GDP
	million rupees				
1964-65	440.6	818.9	-378.3	85.8%	22.5%
1970-71	400.6	699.1	-298.5	75.5%	12.3%
1974-75	889.6	1814.6	-925.0	104.0%	16.3%
1979-80	1150.5	3480.1	-2329.6	202.4%	19.4%

SOURCE: Nepal Rastra Bank [1981]; Ministry of Food and Agriculture, HMG [1978].

commodities and destination/origin--a matter of concern for the policy-makers of the country.

Table 6 shows that both imports to and exports from India were more than 98% in 1964-65. Until the mid-1970s, they remained above 81%. Lately, the shares have come down to 45.3% in 1979-80.

Food comprised a significant percentage of exports (Table 7). Food and crude materials ("0" + "2"), a measure of agricultural exports, represented 85% of total exports in 1964-65, and decreased to 67.5% in 1979-80. It is the stated policy of the government to bring about increased diversification of trade, both in terms of exports and imports. The policy is to favor development goods in imports (Table 8) and the trend indicates that the policy has been effective.

The stated government policy has been to increase not only the rate of growth of development expenditure but also its share in the total budgetary expenditure. Table 9 shows that development expenditure has remained at about 64% of total expenditure throughout the period. Foreign aid has comprised about 63.2% of total development expenditure in 1979-80.

Another feature of government finance in Nepal has been the alarming rate at which the budgetary deficit has been increasing. The deficit, as a proportion of total revenue, has increased from 8.5% in 1964-65 to 22.1% in 1974-75 and to 58.7% in 1979-80. This rate of increase is viewed with concern in Nepal, where the money market is not well developed and the government deficit is often directly reflected in an increase in the money supply. The result is often strong inflationary pressures and the attendant problems of instabilities.

Table 6. Direction of trade

	Imports from India as % of total import	Exports to India as % of total export
1964-65	98.5%	98.8%
1970-71	88.2%	98.7%
1974-75	81.3%	83.9%
1979-80	51.3%	45.3%
Fifth Plan	58.4%	57.1%

SOURCE: Nepal Rastra Bank [1981]; Ministry of Food and Agriculture, HMG [1978].

Table 7. Structure of exports

	Food "0"*	Food & crude materials "2"	Total exports	Food as % of X**	"0" + "2" as % of exports
	million rupees				
1964-65	258.9	374.8	440.6	58.8%	85.1%
1970-71	264.2	244.5	400.6	65.9%	86.0%
1974-75	527.5	730.8	889.6	58.2%	87.2%
1979-80	306.5	776.1	1150.5	26.6%	67.5%

* NB: "0" and "2" represent SITC "0" - "2" classification of food - live animals and crude materials, inedibles except fuel. So, "0" + "2" could be regarded apprxoimately as exports of agricultural products.

** X represents total exports.

SOURCE: Nepal Rastra Bank [1981]; World Bank [1983].

Table 8. Structure of imports

	Consumption goods (C)	Development goods	Total imports	C-goods as % of imports
	million rupees			
1964-65	556.0	262.9	818.9	67.9%
1970-71	455.9	242.2	699.1	65.2%
1974-75	999.5	845.0	1814.6	55.1%
1979-80	1827.2	1682.6	3509.8	52.1%

SOURCE: Nepal Rastra Bank [1981].

Table 9. Government finance

	Total expenditure	Revenue	Deficit*	Deficit % revenue	Development expenditure	Foreign aid	Foreign aid as % development expenditure	Development expenditure as % total expenditure
	million rupees							
1964-65	349.9	192.3	-25	---	231.9	141.0	60.8%	66.2%
1970-71	769.5	459.7	39.1	8.5%	465.0	304.0	65.3%	66.0%
1974-75	1491.0	1006.4	222.7	22.1%	967.2	342.2	35.4%	64.9%
1979-80	3542.1	1732.6	1017.3	58.7%	2969.6	1876.0	63.2%	63.8%

* Deficit = total revenue + foreign grants - total expenditure. In Nepal, government expenditure is classified into development and regular expenditures.

SOURCE: Nepal Rastra Bank [1981]; World Bank [1976, 1979b, 1983].

About two-thirds of GDP in Nepal originates in agriculture. And, about 89% of the labor force is engaged in agriculture. Some 80% of Nepal's exports are made up of rice, jute, pulses and oil seeds. It has been aptly observed that

> Agriculture will have to be the engine for development since it will have to meet increasing food and other basic needs of the population, create employment opportunities, distribute income more equitably, raise domestic resources for future development and increase foreign exchange earnings to import much needed capital equipment. [World Bank, 1979a:4]

Agriculture received hardly any attention, except for a few irrigation schemes, in the overall development efforts before the 1970s. The first three plans concentrated on infrastructural development.

In spite of being a predominantly agricultural economy, agriculture's performance in the 1970s was disappointing [World Bank, 1979a:7]. Its growth was around 2.2% per year, barely in pace with population growth rate at about 2.65% and certainly much below targets set for the Fourth and Fifth Plans (at 2.8% and 3.5%, respectively). Per capita food grains production declined, while cash crops faired only somewhat better [World Bank, 1979a].

Paddy, maize, wheat, millet and barley are Nepal's major food grains. They account for 90% of total cropped area and 80% of agricultural GDP. Output growth in food grains thus largely determines overall agricultural growth.

In the 1970s, output growth of paddy, the main crop, averaged about 1.5%, mainly through extending the area of cultivation rather than increased productivity. Yields increased at only 0.3% per year. Maize output stagnated as yield rates declined at 0.7%. Maize is a very important crop in the hills, where two-thirds of the

population resides. Wheat is a relatively new crop and has averaged 9.6% growth in the 1970's, with yield rate increases of about 2.7% per year. The production of millet and barley, mainly raised in the hill and mountain areas, showed no significant production growth. On the whole, the "production record of food grains in the 1970s leaves room for much concern and has marred Nepal's agricultural record for the period" [World Bank, 1979a:8].

Cash crops,[2] mainly raised in the Terai, accounted for 9.5% of the total cultivated land and averaged about 2.8% annual growth in production. It is also markedly below the output growth target of 10.9% visualized for the Fifth Plan Period. Even this meagre growth has been possible

> . . . mainly because of remunerative government price support and increasing price incentive due to the "exchange premia" offered under the Exporter's Exchange Entitlement (EEE) scheme. [World Bank, 1979a:8]

Data in Table 10 show the agricultural production in Nepal failed to register significant growth and has fluctuated by ups and downs. Clearly, stabilization in the Nepalese agriculture is an important issue.

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[2] In Nepal agricultural crops are classified into two groups, food grains and cash crops, which mainly include oilseed, jute, potato, sugarcane and tobacco.

Table 10. Index of agricultural production

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
All commodities	102	100	97	107	107	110	109	105	108	101
Food	102	100	97	107	108	111	110	105	109	101
Cereals	103	99	92	107	108	111	108	102	105	92
Per capita food production	101	99	93	101	100	99	96	90	91	83
Per capita cereal production	102	98	89	101	100	99	94	87	88	75

NOTE: 1969-71 = 100.

SOURCE: World Bank [1979a]; FAO [1981a].

CHAPTER III
LITERATURE REVIEW

The Agricultural Sector in Perspective

It has been traditional to view the problem of agricultural development as exclusively a problem of increasing agricultural output. Consequently, the attention of practicing agricultural policy-makers and most of the literature in agricultural economics is usually circumscribed within the limited concept of agricultural development. Sufficient sophistication and details have been achieved in the analysis of agricultural problems, system, and transformation at the macro level. Curiously, however, not much is appreciated about the fact that economic policies, directed at the general economy, exert a very strong influence on the agricultural development--be they fiscal, monetary, or trade policies. As Schuh observes,

> All too frequently, agricultural economists tend to ignore these policies in their research and analytical work. We tend to concentrate on those policies which are explicitly defined as "agricultural policies" and which bear directly on our sector of interest. [1968:1283]

The failure to recognize the importance of general economic policies has three far reaching consequences for errors which (a) affect the efficiency with which resources are used, (b) alter the distribution of income, and (c) affect the rate of aggregate economic growth [Schuh, 1975:1]. Indeed, "general economic policy may be as important as, or more important than, sectors" [Schuh, 1975:1].

For instance, trade policy has been an important means of discriminating against agriculture in most countries, and of affecting the distribution of income [Garcia, 1981; Quezada-Salcedo, 1981; Schuh, 1968, 1975; Timmer et al., 1983].

Thus, one of the problems with the agricultural sector is that it has generally been circumscribed within only limited perspective--much to the neglect of the macro environment within which the agricultural sector could really foster. We now examine some historical perspective of agriculture in view of its wide-ranging policy implications.

Agriculture and the Rest of the Economy--Evaluation of the Theory

It is now generally recognized that agriculture has long remained ignored in the literature, particularly vis-a-vis its role in the process of economic development. In that context, the works of Johnston and Mellor [1961] provided important insight into the long process of recognizing the agricultural sector as a potentially positive factor in development rather than just as a repository of resources. Running close to this is William Nicholl's sorely neglected concept of an "agricultural surplus" [1963:1-29]. His analytical framework, although based upon a one sector model, helps us

> . . . to concentrate on the importance of producing a product surplus, as contrasted to the misguided concern with labor surplus, and directs our attention to the way in which that product surplus can be generated, to the inter-relations between population and the agricultural surplus, and to the ways in which the agricultural surplus can be used. [Schuh, 1975:3]

It is to this end, of generating product surplus and not just concentrating on the exploitation of the apparently existing surplus labor in

the agricultural sector, that the positive and dynamic role of agriculture could best be appreciated.

Similar discussions are found in the model of development by H. G. Johnson [1967] too. His focus is on the dynamic role that food aid could play in economic development. Special emphasis is placed on the role of wages-good in capital formation for economic development. The emphasis is on food aid and/or imports, running closely with the two-gap model a la Chenery [Chenery and Strout, 1966]. For instance, food aid helps to close the two gaps—(1) the savings gap, and (2) the transformation gap—simultaneously in the process of development. Since a decision to industrialize (or modernize) implies also stepped up imports of intermediate inputs and capital goods, there is a problem of incurring trade imbalance in most developing countries.

In order to complete this theory of agricultural development, Schuh [1975] adds two other pieces of theory. The first is the Hayami-Ruttan induced development model [1971] which argues that relative factor scarcities influence the particular technological path which an economy follows as it develops. The production technology is expected to play an important role in the growth process of facilitating the substitution of modern inputs produced in the nonfarm sector for conventional on-farm resources, thereby easing the constraints imposed by low supply elasticities for the latter [Schuh, 1975]. In addition, the research efforts need to direct technical change on to an efficient resource path; otherwise, output growth will be sacrificed and the growth rate will be lower than it otherwise would be [Schuh, 1975].

The second piece of theory which helps to make an almost complete picture of agricultural development has to do with the labor market and

what has been called the agricultural transformation [Johnston, 1970: 369-404]. The income elasticity of demand for agricultural products in aggregate is low relative to the demand for nonfarm goods and services and declines as per capita income rises because of Engel's law. If product supply curves were to shift to the right at the same rates, the differences in income elasticities would in themselves require the transfer of resources from agriculture to the nonfarm sector, largely because countries start the development process with the bulk of their resources in agriculture [Schuh, 1975]. One could thus appreciate the dynamic role that agriculture plays towards higher levels of industrial and general economic growth.

Against the common background of a lopsided view of agriculture, the recent alarms concerning the food problem have produced a healthy shift in emphasis. Development economists and governments are now giving more attention, at times more than is due, to agriculture. In fact, Schuh goes even to the extent of warning that

> We are now in the danger of going to the other extreme, with some analysts arguing for an agriculture-first policy as contrasted to an industry-first policy. And perhaps more seriously, at least for some countries, targets are being set in terms increasing food output only. [1968:12]

It is this aspect that was addressed at the beginning of the present section, when it was emphasized that the literature on food and agricultural policy remains constrained within the micro focus only, much to the neglect of the macro environment within which that agricultural sector must develop [Timmer et al., 1983:457].

On the other hand, a good deal of sophistication has been achieved in macroeconomic/macroeconometric modeling in the literature. Yet most models fail to incorporate agriculture in any significant way, albeit

the agricultural sector may be playing a dynamic role in the process of development. This aspect is addressed in the following section.

Agriculture in Macroeconomic Models

Most literature on economic development is cast in the context of the need and realization of technological changes with the main focus on the so-called "agricultural transformation"--a process whereby an important share of agricultural labor force is transferred out of agriculture and correspondingly new modern inputs produced in the nonfarm sectors are introduced. (For extensive discussion of the U.S. case, see Schuh [1976:802].) To this, one could include the additional role of agriculture in providing the needed surplus for the development of the nonagricultural sector. Yet the nonagricultural sector has remained the centerpiece of the literature and the conduct of development policy in most developing countries. This fact has been the main reason why agriculture has been usually considered more as just a source of surplus for the pursuit of the nonagricultural sector--in terms of both human (labor) and nonhuman (capital) resources. One consequence of this lopsided view has been that agriculture is often manipulated continuously through various pricing policies in order to maintain depressed prices of food at artificial levels in the urban areas, resulting in what is known as the "double squeeze of agriculture" [Lipton, 1977:20]. The controlled prices of agricultural products, the result of deliberate economic policy, have consequently helped to depress agriculture through the fixing of unremunerative prices which have only led to stagnant agricultural production inspite of significant potential for comparative advantage in production and

trade [McCarthy and Taylor, 1980; Schuh, 1978]. In the process, this stagnation has caused a drain on available foreign exchange, since most of the developing countries have become net food importers, with an adverse impact as much of available foreign exchange has had to be diverted away from investment to importing food in substantial amounts (e.g., wheat import in India).

It has been aptly noted that

> The literature and much of the practice of development policy has been dominated by either emphasis on industrialization, independent of agricultural development, or on agriculture as a provider of basic human needs, independent of commercialization and industrialization. Perhaps the time is ripe to pick up the old threads of dynamic interaction between agriculture and industry. [Mellor, 1982:2]

It has been found, e.g., in the Indian case [Rangarajan, 1982], that the value of consumption goods, mainly from the nonagricultural sector, consumed in rural areas is nearly two and a half times larger than the proportion consumed in urban areas. The study demonstrates that these consumption linkages are much more powerful than the links due to the use of inputs by agriculture or provision of raw material. That is, agriculture's role is not to be limited just in providing surplus or limited market for inputs produced in the nonagricultural sector. It has an important and dynamic role in providing extensive market for final goods from the nonagricultural sectors.

Macroeconometric Modeling

General Theoretical Issues

A simple closed economy. In modeling an economy, it is helpful to view the economy in terms of the "circular flow" [Ackley, 1961;

Gordon, 1978; Taylor, 1979, 1983]. In a simple closed economy without the government and international trade, the economy is composed of two sectors--the consuming sector and the producing sector. These two sectors interact in the following ways: (1) the consuming sector (which could be identified with the household sector) offers productive services, in the form of labor, to the producing sector through the factor market. They are, in turn, rewarded by the producing sector (which could be identified with the firm) through factor payments, in the form of wages, salaries, rents, profits, etc. Hence, there is a flow of money from the producing sector to the consuming sector. This flow of money constitutes the money income of the consuming sector.

The other interaction between the consuming and the producing sector is that the consuming sector uses its money income to demand the products produced by the producing sector. In principle for the closed economy in equilibrium, the flow of money between the two sectors must be equal, i.e., the amount of money spent by the consuming sector in goods and services is equal to the amount it receives in return for factor services it offers to the producing sector.

Extension of the simple model. The above is the basic model and is only a building block of macroeconomics. It forms a simplistic view of the economy and ignores several important real features of the economy, e.g., the government and the opportunity to trade, which affect GNP in several ways. They need to be incorporated in essential ways for making the model more realistic.

Government. The government raises revenue by taxing the private sector, and this has the effect of decreasing GNP. On the other hand,

it spends the revenue on goods and services, and this has the effect of increasing GNP. All the more, the taxing and spending activities do not have symmetric effects. As a result, the government activity can have the net effect of raising or lowering the equilibrium level of money in the economy. Still further, the government can take recourse to deficit financing, causing a net addition of money, and so could actively participate in the process of producing goods and services.

International Trade. The introduction of international trade in the simple model has the effect of altering the equilibrium level of money flow in the economy. Exports of goods and services has the effect of outside injection of money into the economy. Similarly, import of goods and services implies a leakage of money outside the system.

Savings. In the simple closed economy, it is assumed that indviduals spend all their money incomes on goods and services. However, in the real world, individuals can save and borrow, thereby altering the time profile of their consumption from income. These choices have the effect of altering the time pattern of equilibrium level of money in the circular flow. The desires of the individuals and the firms to save and/or borrow necessitates the existence of a financial system, formal and/or informal, wherein money available from savings is made available to potential borrowers. The financial system is often regulated by economic policy aimed at a certain goal in the time pattern of the equilibrium level of money. Clearly, the inclusion of foreign trade and the financial system (indicating leakage and/or

additional injection of money) adds further complications to the model in that economic variables, such as the aggregate price level, the level of foreign exchange, the extent of government operations, etc., become important.

Usually, the policy-maker has to judge an economic policy in terms of its effects on the equilibrium level of money, aggregate price level, the balance of trade, and payments--broad economic variables economic policies must address. Still, depending on the socio-political commitment of the policy-makers or the economic system, it may be necessary to include such factors as income distribution which is considered very important in most developing countries.

It is the role of the macroeconomic theorist or the macroeconomic model to provide hypotheses about the effects of particular economic policies. A macroeconometric model helps to test these hypotheses within the particular existing institutional and economic structure of the economy and come up with quantitative estimates of the effects of proposed policies.

Standard Macroeconometric Methodology

The standard procedure in building a macroeconometric model is to begin with a set of national income accounting identities representing the amount of money flowing through the economy. An accounting identity that measures the total aggregate demand for goods and services is usually written as follows:

$$GDP = CP + CG + GFKP + GFKG + X - M$$

where

GDP = gross domestic product,

CP = private consumption,

CG = government consumption,

GFKP = gross capital formation by the private sector,

GFKG = gross capital formation by the government,

X = exports, and

M = imports.

Similarly, an accounting identity measuring the flow of money through the factor of production market is written as

GDP = wages + rents + interest payments + indirect taxes + capital consumption.

There can be many variations applied to these identities in terms of defining economic variables (e.g., national income, personal income, personal disposable income, etc.) and disaggregating various components. They depend upon, among others, the purpose of the model and the availability of data.

The building of a macroeconometric model, in general, involves the setting up of a system of national income identities in accordance with the use to which the model is intended to be put and determining which variables one wants to treat as endogenous and so explain and forecast. Such a judgment on the variables, their nature and relationships, is mainly based upon economic theory. Needless to say, the practical problems of specification are related to deciding, on the basis of economic theory and statistical criteria, which variables are to be

considered important dependent variables, as contrasted to predetermined variables in the model.

Given data on the dependent and independent variables, structural parameters are estimated, using standard statistical inference procedures. The structure of the model provides the static picture of the economy. Important uses to which the structure of the model could be put are in estimating the effects of changes in exogenous variables and other policy actions [Evans, 1970].

Macroeconometric Modeling in Developed Countries

Theoretical Issues

Econometric models were first built and applied in Holland and the United States. There were serious efforts to build such models in the UK, Japan, Israel, etc. These models, used in the developed industrial countries, were basically Keynesian in nature. Among the pioneering models were those by Tinbergen [1939], Klein and Goldberger [1955], and Suits [1962] for the U.S. economy, Ichimura et al. [1964] for the Japanese economy, and Tinbergen [1951] for the UK economy.

Most of the models are inherently in the Keynesian framework and are mainly demand-led. The Keynesian theory of effective demand remains the central theme of these model-building efforts. The associated growth of the social accounting system has enabled econometricians to put the Keynesian system in explicit form. Klein [1968:561] gives the popular Hicks-Lange version of the Keynesian theory in a parametric linear form as follows:

$$Ct = \alpha_0 + \alpha_1 Y_t + \alpha_t r_t + u_t$$

$$It = \beta_0 + \beta_1 Y_t + \beta_t r_t + v_t$$

$$Yt = Ct + It$$

$$Mt = \delta_0 + \delta_1 Y_t + \delta_t r_t + z_t$$

where

Ct = consumers' expenditure,

It = capital formation,

Yt = national income,

r = interest rate,

Mt = money supply (exogenous), and

u, v, z = random errors.

It is a very simple version. The system is not identified; it is not dynamic and does not deal with price-level determination. It does not, for example, include government variables (expenditure and taxes) and does not incorporate foreign trade. Indeed, modern econometric models have been largely an outgrowth of efforts towards a greater dose of realism. Naturally, efforts have gone mainly in the direction of introducing prices, wages, dynamic behavior, employment, trade, the role of the public authorities, etc. Yet, most of the extended versions have remained basically Keynesian because, once prices are given, effective demand (or total income) is also determined--inherently as a function of a set of exogenous variables.

Historically, such econometric models, cast in the Keynesian mold, have exhibited a more realistic depiction of the economy, in terms of the analysis of the industrial economies and also policy conclusions

with extensive application to several policy issues. Klein emphasizes that these models are generally

> . . . descriptive of the American economy because we have an enormously productive industrial complex that is physically capable of turning out much more output than it actually does, and our problem is to find enough effective demand to absorb its output. [Klein, 1968:568]

The focus of the econometric modeling for the developed industrial countries is in generating more effective demand and could surely be regarded as problem-oriented or problem-specific in their situations. The stress is upon the decomposition of national expenditure. This gives greater importance and detail to the demand side of the national income accounts. On the other hand, there is no similar detailed account of the supply side.

General Features of the Empirical Models

Most models contain at least one consumption, investment, liquidity preference, and production function (see Nerlove [1966]). Many have quite elaborate systems of equations corresponding to some of the elements given above, depending upon the individual country's economic environment. Some models are dynamic, and most contain at least a few nonlinearities too. Although the specification of exogenous and endogenous variables is important, not all do make that distinction explicit. This omission creates unnecessary difficulty in capturing the operational aspect of the model in terms of identifying the policy variables,[1] which are of greater concern to the policy-makers. Most of the equations have been estimated mainly by

[1] Policy variables are exogenous to the system and could be influenced by the policy-makers.

employing the Ordinary Least Square Method (OLS), e.g., Tinbergen [1939], Tinbergen [1951], Valvanis [1955], Suits [1962], Dusenbury et al. [1960], Brown [1964], Kmenta [1964], and Ackley [1963]. Klein and Shinkai [1963] used Two Stage Least Squares (TSLS) in their model for Japan. Valvanis [1955], Klein et al. [1961], Rhomberg [1964], and Klein and Goldberger [1955] have, wholly or partially, employed the Limited Information Maximum Likelihood Method (LI).

In most of the models, government wage bill or expenditure, population, supply of agricultural commodities, bonds issued by the government, required reserves, net income from abroad, value and volume of exports, value and volume of imports, index of world production, and prices of goods, etc., are treated as exogenous variables. Most models have considered real consumption expenditures, real net investment, active balances (cash balances and demand deposits), idle balances (time deposits), gross output of the private sector, private wage bill, general price index, and rent payments as endogenous variables in the models.

It is characteristic of most of these models that each takes due account of the individual characteristics of the economic topography of the concerned countries. The model for UK, for instance [Klein et al. 1961; Tinbergen, 1951], and the Netherlands [Central Planning Bureau, 1961] incorporate in significant ways the large size of the international sector. They could be contrasted with most models for the U.S. with no significant external sector, because foreign trade is considered to form only a small part of the overall economy.

In countries where international trade occupies a relatively significant share in national income, greater disaggregation of the

foreign trade sector is needed. This is true of countries like Japan, with a relatively large share of foreign trade in the national economy [Klein and Shinkai, 1963]. In the case of Australia, Kmenta [1964] emphasizes the effect of immigration on key variables in the economy, especially to the housing industry through resultant housing demand. Monetary sector is absent, and price level is determined by minimum wage levels, excess demand for labor, and immigration. This could be contrasted with other models for the U.S. [Tinbergen, 1939], which give extensive treatment of the monetary sector.

Thus, it is very important that an individual country's special economic and institutional characteristics be adequately reflected in any economic model. A model of Israel, for instance, would give greater weight to population growth through immigration and natural increases, unilateral international transfers, military expenditures for defense, trade balances, and domestic capital formation [Evans, 1970]. Similarly, a model for Japan would highlight such features as the foreign trade movement, the savings process, the controlled money market [Klein, 1968:560], and the extensive and sustained government support for export promotion.

Macroeconometric Modeling in Developing Countries

Theoretical Issues

As a consequence of substantial efforts to construct large and sophisticated econometric models in developed countries in recent times, a large and growing literature on the techniques of specification, identification, estimation, and forecasting, as well as

simulations of these large macroeconometric models, has become available. However, the application of these techniques to developing countries is still a very recent phenomenon [Klein, 1968]. The reasons often cited for this dearth of available macroeconometric models for developing countries are lack of large and disaggregated time series data over a fairly long period of time and the shortage of expertise required to carry out major efforts of this nature [Klein, 1968; Hansen, 1973].

Perhaps the most vexing question in the context of modeling in developing countries is, could modeling techniques, including underlying theoretical specifications of the models for the developed countries be reasonably carried over to the developing countries? This problem was early and aptly posed by Klein.

> It is not clear to what extent guidelines that have been established for the model builders in the former group (developed countries) should be used in the latter (developing countries). [1968:576]

In most of the pioneering econometric models--Tinbergen [1939] and Suits [1962] for the U.S. economy, and Klein and Shinkai [1963] and Ichimura et al. [1964] for the Japanese economy--the emphasis is on the demand side which remains the centerpiece of these models. Not unnaturally, one of the causes of caution in transplanting these models into the developing countries has been whether it is reasonable to use neo-Keynesian macroeconometric models for the developing countries. In an economy where economic resources are allocated to some degree by the price system, the levels of macroeconomic variables are certainly determined to a significant extent by aggregate demand and aggregate supply of goods and inputs [Stephenson and Itharattana, 1977].

Under given technological and institutional constraints and the situation where the price mechanism is used to allocate resources, there is certainly a justification for the application of the Keynesian framework in the developing countries too. However, its blind application should be forewarned, keeping in mind the special institutional and economic characteristics prevailing in the economy being modeled. Klein argues:

> Some parts of the Keynesian type aggregative structure are universal, while others are not applicable outside the industrial economies for which they have been established. [1968:576]

General Features of the Empirical Models

The earliest macroeconometric models, built especially for LDC's (e.g., Narasimham [1956]; Suits [1964]) followed closely the simple Keynesian models. This has exerted a great deal of influence on modeling efforts in the developing countries. However, the kinds of models proposed for LDCs have begun to undergo some perceptible changes, e.g., towards incorporating more neoclassical formulations by giving special emphasis to relative prices and profit maximization [Zerembka, 1967, 1972] and towards making greater use of expectational variables based upon distributed lag formulations [Evans, 1969, 1970].

With extended disaggregation, "the large role that foreign trade plays in most LDCs has become increasingly reflected in the more recent models" [Nugent, 1975:510]. However, the fundamental break with the developing countries' tradition of keeping the effective demand the centerpiece of the macroeconometric models has been in putting more emphasis on supply considerations [Marwah, 1969a, b; Beltran del Rio

and Klein, 1974; Ali et al., 1977]. Major efforts have gone towards further disaggregation of different production and consumption funtions for various sectors [Islam, 1965; Zarembka, 1972]. As a consequence, it has been possible to incorporate Nurkse-Lewis notions of agricultural surplus and market imperfections into the empirical LDC models which has helped to better reflect economic and institutional features.

Whereas most of the earlier macro models, e.g., Feldman/Mahalanobis model [Mahalanobis, 1953] were inspired by the closed economy models of Harrod-Domar and Keynes, "the large role that foreign trade plays in most LDCs is increasingly reflected in the more recent models" [Nugent, 1975:510]. Most of the changes that have been profitably incorporated recently in the design of macroeconomic/macroeconometric models are essentially in scope, level of aggregation, and emphasis. Nugent suggests that improvement is clearly warranted in incorporating more explicitly

> . . . the disequilibrium nature of development processes and structures and integrating short-, medium-, and long-range time perspectives, relating these models more closely to the requirements of developing planning and policy decisions. [1975:511]

To that extent, economists have increasingly come to realize that the "real" world is less than "perfect," and the "first-best" solution or adjustment mechanisms cannot be utilized because of political-administrative, social, and economic constraints. Indeed, many daulistic differences which are observed between sectors, have a tendency to perpetuate. Part of the reason may be the result of faulty policies. However, "partly the dualisms also seem to be due to the relative strength of various disequilibrating forces that seem to

appear naturally in the process of economic development" [Nugent, 1975:511]. To say the least, the failure of several phenomena, such as prices, technology, savings behavior, human capital, and the sectors themselves to come to equilibrium is important to account for in the design of macro models for developing countries.

The upshot of the foregoing discussions is that a proper strategy is to construct a simple model for a developed country, and then seek to reexamine and modify its applicability to the modern stabilization analysis of the special situations of the developing coutries [Behrman, 1974, 1975; Klein, 1968; Zarembka, 1972]. The crucial step lies in the examination of various components of recent models for stabilization in developed countries and to consider how and in what respects they could be modified for the analysis of stabilization issues in a developing country, given the economic and institutional topography of the developing country.

Having discussed the general features of macroeconometric modeling in developing countries, we now discuss the distinguishing features of some empirical macroeconometric models for developing countries.

Features of Some Empirical Models

Among early macroeconometric models for developing countries is one by Narasimham [1956]. It is a short-term macroeconometric model for India and is basically cast in the Keynesian framework. It consists of four groups of relations: (1) definitional, (2) demand relations, (3) price fixation relations, and (4) income formation relations. The five definitional relations in the model define

(1) volume of national product, (2) price of national product, (3) value of national income, (4) national income, and (5) noncorporate profits.

The second group of relations, concerning the demand functions, relate to (1) consumption function, (2) investment function, (3) import demand function, and (4) labor demand function. The third group of relations, concerning price fixation, relate to (1) consumers' price, (2) investment price, (3) wage rate (labor price), and (4) farm price. The final group, concerning income formation, relates to (1) non-corporate profits, (2) profit of the corporate sector, (3) farm income, (4) nonfarm labor incomes, and (5) tax yields. The Indian economy is described by a system of five markets for factors and products through a system of equations.

While Narasimham's was a pioneering attempt, he appears to have paid "insufficient attention to adapting the Tinbergensque models to the very different structural features of the Indian economy" [Bhagwati and Chakrabarty, 1969:28]. These would relate, for example, to the distinction between "urban and rural propensities to save, the elasticity of the marketable surplus in agriculture, the distinction between factory employed labor and self employment, and so on" [Bhagwati and Chakrabarty, 1969:28].

The model for Tunisia by Ali et al. [1977] is also a short-term model. Yet it incorporates the "production side" in an essential way. This could be contrasted with the common practice of incorporating only the demand side in short-term macro models--to the extent of identifying short-term macroeconometric modeling only with the demand side of the economy [Behrman, 1976].

Ali et al. [1977] incorporate capacity utilization variables as exogenous but manipulable as policy instruments. Financial variables, e.g., bank and government credits and foreign exchange reserves, play a crucial role in determining investment expenditures in the model. The economy is disaggregated into seven blocks: (1) a production and employment block; (2) price equation block (economy wide decomposed into 14 branches); (3) a foreign trade block containing import and export equations for various trade categories; (4) an investment block; (5) private and public consumption equations as well as equations for direct and indirect taxes; (6) petroleum branch; and (7) an inventory change, calculated residually (as demand minus supply), which also measures the disequilibrium in the economy.

The equations of the model are presented in log-linear form for easier interpretation. The model has 59 behavioral equations and 36 identities, with 77 exogenous variables. The model is expressed as a simultaneous equation model.

One vital use of the model relates to the simulation of the past. Some important features are (1) the Gauss-Seidel iterative method is used to solve the system of nonlinear equations; (2) a dynamic simulation resulting over the sample period 1963-66 is presented for a sample of variables; (3) the impact of various policy instruments on target variables is studied by performing alternative simulation runs using different sets of instrument variables and (4) values of the target variables obtained from the alternative simulation are compared with those of the reference solutions in order to analyze the response. Policy impact is studied regarding (1) the government increases investment credit by 10 million dinars yearly; (2) when the indirect

tax increases from 12% to 15% over the forecasting period; (3) when the import tariffs are increased by 10% over the whole period considered; and (4) when investment allocation parameters for the manufacturing industry (reallocation away from long gestation projects) are increased by 1% in 1977 and 1978.

Stephenson and Itharattana [1977] take special account of the importance of agriculture which is treated in an extensive and disaggregated manner. Emphasis is placed upon investigating the relationship between the agricultural and the nonagricultural sectors. The model is basically addressed to investigating the effects of alternative policy proposals with particular emphasis on increasing agricultural production and income. The entire model consists of two components (1) a national agricultural model within the framework of the standard linear programming analysis and (2) a macro-econometric model.

Their model-I is a very simplified and crude version involving 45 equations of which 36 equations are behavioral. It is a completely "real" model without consideration of the monetary sector and so involves no consideration of aggregate price levels. The model consists of seven general groups of equations relating to (1) private personal consumption, (2) government expenditures, (3) exports, (4) imports, (5) gross fixed capital, (6) output, and (7) income distribution. The OLS estimation method is employed, using annual data for 1962-1974 (2SLS method is not used because of the small number of time series observations).

Model-II is also a self-contained model. Built upon Model-I, it incorporates nonlinearization of variables (though not of parameters)

and also includes a monetary and price sector. Unlike Model-I, six of the seven output equations are specified in modified Cobb-Douglas production function forms with the seventh in an output per worker form.

Although an attempt is made to monetize the economy, Model-II still does not incorporate the financial sector satisfactorily. The authors recognize the need to incorporate balance of payments and foreign exchange positon of Thailand in order to make the model more realistic. Greater realism could be obtained by incorporating sub-models of the export commodities directly into the model.

Intended for the purpose of the application to some hypothesized policy choices over time, Norton and Rhee [1981] assess (1) the role of exports in generating growth and inflation; (2) the role of money supply for growth and inflation; (3) the effect of 1974 "oil crisis" on domestic economic performance; and (4) the role of wage increases, agricultural price increases, and import liberalization in determining inflation rates.

An important historical experiment of the model relates to alternative time paths posited for import and export price variables and the volume of world trade or exports. Some previously exogenous variables, e.g., those related to export levels and international terms of trade, are made endogenous for such an experiment, with addition of equations related to trade and exchange rates and deflators of national accounts.

Policy simulations are carried with respect to the likely effect of a 5% lower export growth and a 5% reduction in the money supply on GDP, the percentage of manufacturing employment, the balance of

payments position and inflation. The monetary experiment, reflects the greater degree of endogeneity of money supply.

The system is recursive in structure. This facilitates the use of the OLS estimation procedure. It is a demand-led model, without any consumption function but only its residual specification. Demand, which clearly stands central, is determined by expectations which in turn are related to (1) price and (2) effective demand levels. Output is determined by demand expectations and output determines capital stock; which is the principal determinant of savings. The residual specification of savings thus follows.

The Norton-Rhee model contains 17 stochastic equations and 24 identities, with the principal endogenous variables in output, price level, wage rate, imports, inventory investment, savings, consumption, and employment. The policy instruments specified are (1) the exchange rate, (2) nominal money supply, and (3) farmers' selling price for agricultural products.

Although the focus of the literature on development and planning has mainly centered on the relationship between agriculture and industry, yet surprisingly, not much work has gone on in the direction of putting the scope and extent of such relationship in suitable macro-econometric framework which could permit both quantification of the relationship and also testing of relevent hypotheses. Rangarajan [1982] addresses especially this lacuna. A macroeconometric model, incorporating the relationships between agriculture and industry through production input requirement, demand, savings, and investment, is constructed to study the effects of agriculture on the economy. The model examines what would be the effect on industry if agriculture grew

at a certain percentage. Such an exercise is important especially for development planners who often are hardly left with perspectives and alternative paths of industrialization vis-a-vis agricultural development, although the relationship between the two is emphasized mostly on a theoretical basis.

To test the model, simulated values derived from the model were compared with the actual values. The model was able to capture fluctuations in industrial production and growth of basic and capital goods. Five simulations were attempted to examine the efforts of various paths of agricultural development--in terms of steady growth, a one-time increase in agricultural output, and a change in the foodgrain terms of trade (i.e., terms of trade between industry and agriculture). The model specifically asked what the effect on industry would be if agriculture grew at a certain rate, based upon historical data (1961-1972).

Important features of the model were that (1) industrial output was divided into two categories, e.g., consumption goods, and basic and capital goods; (2) agricultural output, disaggregated into food grains and nonfood grains, was treated as exogenous; and (3) terms of trade between agriculture and industry were treated as endogenous. Interestingly, the model captured fluctuations in industrial production and wide differences in the values for year-to-year growth of basic and capital goods.

Five simulation studies were carried. Simulation I, the basic simulation, was mainly deterministic, but the model was also simulated stochastically. Simulation II showed the effects of a one-time increase in agricultural output. Simulation III took one variable,

the food grain terms of trade, and examined the effects of changes in it. Simulation IV, examined the effect of a 1% increase in agricultural growth rate. The results of the simulations indicated that a 1% growth in agricultural output increased industrial production by about 0.5% and the national income by about 0.7%.

The model did not incorporate output effect of investment, and money was not introduced in the model since the behavior of the real side of the economy was linked only to relative price ratios. The terms of trade, the output of industrial consumption goods, the output of basic and capital goods, the output of industrial production, gross fixed capital formation of various sectors, and national income were among the principal endogenous variables. The system was recursive, and the ordinary least squares method was employed for estimation of the model. The main conclusion that emerged from the model was that agriculture exercises strong influence on the growth of industry.

Thorbecke and Field [1969] attempted to analyze economic development in terms of vital relationships within the productive sectors and between these sectors and foreign trade. Their analytical framework consisted of (1) a sectoral breakdown in terms of agriculture, industry, and service; (2) a specification of the major relationship between sectors (e.g., technological, income and price relationships); and (3) formulation of a policy framework to evaluate national performance.

The framework was applied to explain the experience of Argentina from the beginning of the century to the present, and the experience of Peru was put into similar analysis for the post-World War II period. In each case, the role of agriculture stood as the centerpiece

of investigation. However, these two case studies provided very different perspectives of the agricultural sector--e.g., (1) the case of Argentina provided interesting insights into the relationship between agriculture and foreign trade when the balance of payment was a binding constraint, and (2) the case of Peru demonstrated a situation where a very contrasting kind of contribution to developmental objectives could be made by a dualistic agricultural structure as compared to the contribution made by an entirely commercialized agricultural sector as that of Argentina.

The model helped to demonstrate that in the case of the economy of Argentina, where balance of payment was a binding constraint to development,

> Development would be best served by a heavier allocation of inputs to agriculture and to exportable consumer goods. The import-substitution policy strangled the supply of capital goods further by favoring consumer goods. This resulted in the interruption of economic growth in an already semi-industralized country. [Thorbecke and Field, 1969:186]

The contrast between contributions to developmental objectives of an entirely commercialized agricultural sector (the case of Argentina) and a dual agricultural sector (the case of Peru) is better appreciated from the model.

Among other features of the model, value added was posited as a function of labor and capital, except for agriculture, where the quantity of land and the amount of rainfall were additional factors that influence agricultural production and lagged capital influenced output. Agricultural production, in contrast to other sectors, was recognized as discontinuous.

The consumption of agricultural products, industrial manufactures, and services were related to changes in disposable income, internal terms of trade, and a variable reflecting changes in income distribution, respectively. Exports were specified as the surplus available after consumption and investment requirements had been deducted from available supply.

Imports were disaggregated into imports of raw materials and intermediary goods, capital goods, and consumption goods. One reason for this was that in Argentina, as in most developing countries, the import of consumption goods is regulated almost entirely by government import control. Imports of raw materials were specified endogenously as a function of the level of output in the industrial sector and the purchasing price via external terms of trade. This specification implies that imported and domestically produced raw material and intermediate goods were considered complementary. The import of capital goods was specified as a residual.

In the econometric model for Israel, Evans [1970] considered the country's special economic topography--immigration, restitutions and reparation payments, and unilateral transfers from individuals in foreign countries--and demonstrates some important predictive power of the model. For instance, the model predicted the recession of 1966 (beyond the sample period of 1952-1962) and thereby made it possible "to explore the question of whether the recession was a natural effect of forces that had been building up in the economy" [Evans, 1970:625], or whether it was otherwise shock-induced and unpredictable. With multiplier analysis, the predictive record of the model for 1966 was

analyzed, and alternative measures of altering the recession of that year were examined.

Marwah [1969a] recognized that any significant economic program, e.g., devaluation in the Colombian case, could be resolved in the light of detailed analysis of the general structure of the Colombian economy. The model had the "foreign sector" as the key determinant of the Colombian economy. An attempt was made to formulate, estimate, and test the basic structure of the system from which policy implications were drawn. After the estimating and testing of the structural parameters, two alternative simulataneous solutions corresponding to the different policy assumptions with respect to devaluation were provided. Finally, the "status quo" solution was compared wih new controlled solutions.

The model used annual observed data (1951-1962). Except for the recursive part of the system, where OLS was justified, all the estimates were obtained by a modified 2SLS method of estimation. The structural equations were related to consumption, investment, export, import, production functions, corporate savings, taxes, and income distribution. Equations were also specified for general prices, the exchange rate, sectoral price, and identities.

A simultaneous solution of the system for the terminal sample period, 1962, was obtained, and computed values were checked against the actual values. Policy simulations were done by taking selected variables as predetermined, e.g., the exchange rate. The simulation of various rates of devaluation with respect to their effects on corresponding variables such as GNP and exports was undertaken.

The model helped to account for the cost and benefits of different degrees of devaluation. For instance,

> Whereas the gains from devaluation are reflected through savings with respect to foreign exchange earnings and expenses, the cost can be measured through the resultant inflationary pressures and their impact on the general consumption level of the people. The cost seems to be further raised by the slackening of any production activity through the lagged response of the real sector. [Marwah, 1969a:251]

We now turn to the specification of the macroeconometric model for Nepal in the next chapter.

CHAPTER IV
SPECIFICATION OF THE MACROECONOMETRIC MODEL FOR NEPAL

The short-term macroeconometric model presented in this section seeks to take particular account of the agricultural and the foreign sectors in the Nepalese economy. It is recognized that the Nepalese economy is quite differentiated, especially across sectors [IFAD, 1979; Fry, 1974] and the government assumes a significant role in resource allocation. The short-term behavior of the economy is our focal point of interest and thus determines the extent of details and disaggregation in the model.[1] The behavioral equations in the model relate to consumption, investment, imports, government operation, output formation, prices, and money.

The specification of the model is based upon the consideration that the best course to build macroeconomic models for developing countries is to pattern such models along the ones for developed countries, incorporating several individual structural features [Klein, 1968; Nugent, 1975; Narasimham, 1956; Suits, 1964; Behrman, 1974, 1975].

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[1] After all, a model "may be said to achieve a great deal if it can successfully focus attention on the most important factors about which judgment has to be achieved" [Suits, 1962:104-132].

Consumption

The consumption function postulates a relationship between income and consumption. It stems originally from the proposition that Keynes [1936:27] made when he wrote "when aggregate real income is increased, aggregate consumption is increased but not by as much as income." This version of Keynes, also known as the "absolute income hypothesis," came under serious criticism since it could not theoretically reconcile some important empirical findings, such as the stable relationship between income and consumption in several industrial countries even though income had increased many fold during the period of study [Kuznets, 1942:30]. Basically, the three alternative hypotheses about consumers' behavior--(1) the "relative income hypothesis" [Dusenbury, 1949], (2) the "life-cycle hypothesis" [Ando and Modigliani, 1963], and (3) the "permanent income hypothesis" [Friedman, 1957]--respond to this question.

In an economy such as the Nepalese, characterized by rising population at near subsistence level, it is often argued that the "relative income hypothesis" provides a better explanation (see for similar arguments, Glower [1982:87]) of existing behavior and for greater predictive accuracy. However, others have used the "permanent income hypothesis" in models for developing countries in order to estimate the consumption function [Stephenson and Itharattana, 1977]. In these models, the lagged values of the consumption variables are introduced in order to capture the permanent income effect [Evans, 1969:24]. In the existing literature, most of the macroeconometric models for developing countries assume consumption is somehow directly

dependent upon current income [Marwah, 1964; Narasimham, 1956; Krishna Murti, 1964; Thorbecke and Field, 1969; Ali et al., 1977; Evans, 1970]. Of course, several authors adopt different variations of the definition of income, e.g., GDP [Glower, 1982], GNP [Marwah, 1969a], and disposable income [Narasimham, 1956; Marwah, 1969b].

While in all models income is the most important variable to explain changes in consumption, several models incorporate other variables to explain consumption. Thorbecke and Field [1969] introduce internal terms of trade between the agricultural and the nonagricultural sectors, besides incorporating a distributional variable in the form of share of wages in the national income.[2] The internal terms of trade enters in an important way in consumption and production also in Chichilinsky and Taylor [1981], Rangarajan [1982][3] and Evans [1970]. Lagged consumption enters the consumption function in order to capture the effect of permanent income in Evans [1970] and Ali et al. [1977].

It is generally recognized that "all variables should be measured in constant dollars" [Evans, 1970:55] in the consumption function. There are both economic and statistical reasons for this. In particular, this assumption conforms the equation to the popular neoclassical property of the demand function being homogenous of degree zero in zero in prices and income.[4] From a statistical point of view, if

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[2]Klein and Goldberger [1955] also make use of this.

[3]Rangarajan [1982] introduces food grains terms of trade and non-food grains terms of trade vis-a-vis the nonagricultural sector in the model.

[4]According to the neoclassical determination of consumer behavior, individual consumption functions are homogenous of degree zero in consumer prices and income, and "the same basic relationship ought to hold at a macroeconomic level too" [Evans, 1969:55]. Indeed, in subsequent

income and consumption both rose only because of price increases, this would introduce yet another element of spurious correlation into the relationship between these two variables.

For an economy like that of Nepal, it may be revealing to incorporate some kind of a demographic variable such as population to explain consumption, especially at lower levels of income. A point that one needs to be careful about is that because consumption, income, and population all have similar trends, the problem of multicollinearity is very much present. Evans [1969:58] suggests expressing income and consumption in per capita terms in order to avoid this problem of multicollinearity which could drastically reduce the efficiency of estimates of the structural parameters. Additionally, such a formulation, i.e., taking per capita consumption and income, helps to account for general welfare change of the people too [Stephenson and Itharattana, 1977:40]. It is not unusual in many developing countries to have income rising but at the same time per capita income falling because population growth rate outstrips income growth (the case of Nepal).

An attempt was made to account for several considerations, as mentioned above, in specifying the consumption function in the present macroeconometric model. However, it was considered necessary to make several modifications upon what could have been theoretically proposed as mentioned above. Instead of using the consumer price index for

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formulations of the theories of consumption function, effects have generally gone to building micro foundations for the macro theories, e.g., the "permanent income hypothesis" and the "life-cycle hypothesis" of consumption are strongly based upon the theory of consumer behavior at the micro level vis-a-vis the maximizing behavior of the consumer (see Friedman [1957] and Ando and Modigliani [1963].

deflating current, nominal consumption, and income, the GDP deflator (PGDP) has been used as a consequence of the following considerations:

(1) The only data available on consumption were on total consumption--private consumption and government consumption and not private consumption separately; so the consumption function was estimated for total consumption.

(2) The estimation of the consumption equation by using consumer price and population deflators only yielded parameter values with signs and levels which were far from what could have been theoretically expected.

In consonance with what has been discussed above, the consumption equation in the present model was specified as follows:

(4.1) $CPR^5 = f(GDPR, CPRLAG)$

where

CPR = Total consumption expenditure deflated by GDP deflator (PGDP)

GDPR = Total real GDP[6]

CPRLAG = Lagged value of CPR

Investment

The specification of the investment function poses a particular problem, especially in a developing country like Nepal. At a general theoretical level, the theory of investment behavior depends on the

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[5] For more complete definition of the variables, see Tables 11 and 12.

[6] Real GDP and GDP at constant prices are interchangeably used in the study.

Table 11. Endogenous variables

PGDP	=	GDP deflator (1964-65 = 100)
CPR	=	Total consumption in million rupees, deflated by PGDP
IGROSR	=	Total investment in million rupees, deflated by PGDP
MCR	=	Total import of consumption goods in million rupees, deflated by PGDP
MDVR	=	Total import of development goods in million rupees, deflated by PGDP
TXIDRZ	=	Total indirect tax receipt in million rupees, deflated by PGDP
TXDRZ	=	Total direct tax revenue in million rupees, deflated by PGDP
GEXPDVR	=	Government development expenditure in million rupees, deflated by PGDP
GEXPRGR	=	Government regular expenditure in million rupees, deflated by PGDP
GDPAGR	=	Agricultural GDP in million rupees, deflated by PGDP
GDPNAGR	=	Nonagricultural GDP in million rupees, deflated by PDGP
PAG	=	Agricultural price in index number (1964-65 = 100)
PNAG	=	Nonagricultural price in index number (1964-65 = 100)
M1	=	Total money supply in million rupees
MR	=	Total imports in million rupees, deflated by PGDP
TXR	=	Total tax revenue in million rupees, deflated by PGDP
GDPR	=	GDP in million rupees, deflated by PGDP

Table 12. Exogenous variables

1.	CPRLAG	=	Lagged value of CPR
2.	GDPRCHNG	=	Difference between the one-period-lagged value and the two-period-lagged value of GDPR
3.	P_PX_I	=	Relative domestic price with respect to export price index of India (= P ÷ PX_I)*
4.	EXSD1	=	SDR-exchange rate with respect to Nepalese rupees
5.	TXMR	=	Import tax rate
6.	TXDR	=	Direct tax rate
7.	IGROSRLG	=	Lagged value of IGROSR
8.	FAIDR	=	Foreign aid in million rupees, deflated by PGDPW, the world GDP deflator (1964-65 = 100)
9.	GEXPRGRL	=	Lagged value of GEXPRGR
10.	FERT	=	Consumption of fertilizer in 1000 tons
11.	PAGPNAGL	=	Lagged value of relative price of PAG with respect to PNAG
12.	XFR	=	Export of food in million rupees, deflated by PGDP (1964-65 = 100)
13.	QAG	=	Quantity of agricultural production in index number (1964-65 = 100)
14.	PMF_I	=	Import price of food in India (1964-65 = 100)
15.	IRESV	=	International reserve in thousand dollars
16.	GBDF2	=	Government budgetary deficit (total expenditure minus total revenue) in million rupees
17.	FAID	=	Foreign aid in million rupees

* P: Consumer price index in Nepal
PX_I: Export price index of India.

theory of optimal capital accumulation, which was given the most thorough pre-Keynesian treatment by Fisher [1930]. This is the only criterion consistent with utility maximization [Evans, 1969:73]. If it is assumed that there are perfect capital markets, then the firm will maximize its present value if it invests in all projects whose present value is positive at the market rate of interest (see Hirshleifer [1958:329-352]). Indeed, Keynes himself thought "his explanation was equivalent to the treatment given by Fisher" [Evans, 1969:75], in explaining investment function as a relationship between the marginal efficiency of capital and the rate of interest.

Thus, according to the conventional theory, investment depends primarily upon the rate of interest. However, one of the most important difficulties in translating this important theoretical construct to an economy like that of Nepal is that the capital market is often far from being perfect. The rate of interest is often found to be depressed through various policy measures at artifically low levels [Schuh, 1968, 1975; Fry, 1974]. Often the real rates of interest are at negative levels (real interest rate meaning interest rate adjusted for inflation). In this situation, the question is not the cost of capital (which should have theoretically been the determining factor for investment decision) but really the availability of capital [Evans, 1970; Fry, 1974; Schuh, 1975]. Capital is often rationed through several nonprice mechanisms. Besides this, the existence of fragmentation in capital markets, e.g., in Nepal [Fry, 1974], is an important problem in relating investment to the rate of interest.

What compounds the difficulty in drawing upon available developed theories of investment is that since the chargeable rate of interest is

regulated or often fixed by the government, it is difficult to find significant variations in the rates of interest that could meaningfully explain changes in investment.

In order to account for the direct government intervention, it is suggested that "investment function must include a variable which uses government intervention as an explanatory variable" [Glower, 1982:91]. In this regard, it is customary to include government investment itself as an explanatory variable (see Wong, [1974:40]). As a proxy, the government development-expenditure is used as an explanatory variable in the investment function.

In the theoretical literature, investment is also considered to be based upon the "accelerator principle," which reflects a certain fixed relationship between capital and output [Evans, 1969:80]. Symbolicially, if $K_t/O_t = \alpha$, where K_t and O_t are capital stock and output, respectively, then $K_t = \alpha \cdot O_t$ and $(Inet)_t = \alpha \cdot \Delta O$, where I_{net} is net investment.[7] Thus, translated from the stock to the flow concept, investment is proportional to the change in output. This formulation is quite appealing, especially when working with economies like that of Nepal, because data on capital stock are generally lacking and the only available data are simple investment data. Many models [Stephenson and Itharattana, 1977] use this formulation, based on the accelerator principle, to explain investment. On the other side, Norton and Rhee [1981], Marwah [1969a, b] Behrman [1977], Evans [1969], Islam [1965] and UNCTAD [1968] established a direct relationship

[7]This is the simple form of the accelerator principle, which posits a certain fixed relationship between capital and output.

between investment and current output/income.[8] Narasimham [1956], on the other hand, assumed investment was dependent upon retained profits, disaggregated into profits originating in the corporate sector and the noncorporate sector. Besides this, UNCTAD [1968], Marwah [1964], Krishna Murti [1964], Behrman and Klein [1970], Evans [1970], Islam [1965], Klein [1968] and Marwah [1969a] additionally postulate a relationship between investment and its lagged value of one period.

Another aspect that may be crucial to understand investment behavior in an economy like that of Nepal is that in the absence of domestic availability of the capital goods sector, a prerequisite for realized investment is the capacity to import capital goods. In order to emphasize this aspect of foreign exchange constraint, the availability of foreign exchange is often included as an explanatory variable in the investment equation. Closely related to this question of foreign exchange availability is the inclusion of foreign aid as a variable affecting investment since foreign aid is an important contributory factor in augmenting overall investment in the economy.[9]

Following the discussion above, investment is considered to depend upon the change in GDP and government investment in the present model. Because of the lack of data on net government investment, government development budget expenditure is used as its proxy variable.

Because of lack of significant variability in the interest rate, mainly due to government intervention in the capital market, the

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[8] This specification may not be in the true spirit of the accelerator principle.

[9] Foreign aid addresses itself simultaneously to both the savings and investment bottlenecks [Johnson, 1967; McKinnon, 1964].

interest rate was not included to explain investment.[10] In view of these considerations, the investment equation in the present model was proposed as follows:

(4.2) IGROSR = F(GEXPDVR, GDPRCHNG)

where

IGROSR = Gross total investment, including private and government investments, deflated by PGDP,

GEXPDVR = Government development budget expenditure, deflated by PGDP, and

GDPRCHNG = Change in real GDP, GDPR.

Trade

Imports

In the theroetical literature of international trade, it is generally recognized that "imports are significantly related to movements in domestic aggregate economic activity" [Evans, 1969:221]. The relative price of imported goods with respect to domestic goods is also an important determinant of imports, although empirical results in some cases have often been elusive. For example, Datta [1964] finds price elasticity of imports in India far from being significant.

The price of imported goods is usually postulated to be exogenous to the system, because there is likely to be very little short-run relationship between movements in domestic prices and international prices, unless one is prepared to accept a situation of a monopsonistic

[10] Inclusion of the interest rate and foreign aid/import of development goods did not improve the results.

buyer-country or that the country is so big that any change in its economic situation causes an immediate and direct effect on the level of economic activity of other countries or the rest of the world. Clearly, both of these situations are untenable with respect to the Nepalese economy.

In his study of the structure of the Nepalese foreign trade, Shrestha [1975] took national income, the relative price of imports with respect to domestic price and the lagged value of imports as the explanatory variables in the aggregate import function. In most macroeconometric models [Ali et al., 1977; Narasimham, 1956; Behrman and Klein, 1970; Evans, 1970; Hansen, 1973; Klein, 1968; Marwah, 1964, 1969a; Norton and Rhee, 1981; UNCTAD, 1968; Stephenson and Itharattana, 1977; etc.], income enters prominently as an explanatory variable in the import equation, while some models have it included with a lag [Stephenson and Itharattana, 1977; Klein, 1968].

Some models include only one import function [Shrestha, 1975; Islam, 1965; Narasimham, 1956]. Most models, however, recognize that there is a greater need to go beyond an aggregate import function, because a disaggregation of imports is very useful in order to be able to relate any import-related policy to the development matrix of the economy. Given the structural characteristics of a country like Nepal, its development could be considered largely a function of the structure of its imports. In the context of Nepal, in view of the existing efforts to attain a high rate of growth, there have been deliberate policy efforts toward increasing the level of investment. However, most of the investment goods (capital goods, industrial raw materials and intermediate goods) have to be imported

in the absence of a domestic base in the capital goods sector. Consequently, the import of what is generally described as "development goods" (the category of investment goods) should depend on the development effort of the country. Therefore, the level of import of development goods could be considered as a function of the level of investment.

On the other hand, the import of nondevelopment goods, since they are mainly consumption goods, would primarily depend on the domestic income as in the case of private consumption. Usually, in an economy like that of Nepal, where the majority of population are at a low level of income with most of their income spent on food, "a separate import function for food would have been warranted" [Evans, 1969:224]. Yet, in view of the fact that Nepal is mainly a food exporting country and there is no significant food imports but only at marginal levels during occasional shortages due to natural causes, there may be no need to construct a separate import equation for food in the present model. It is usually postulated that imports depend upon the relative domestic price vis-a-vis foreign price, the exchange rate, and the import tax rate.

Based upon the foregoing discussion, the import equations for consumption goods and development goods were specified in the model as follows:

(4.3) MCR = F(GDPR, P_PX_I, EXDS1, TXMR)

(4.4) MDVR = F(IGROSR, P_PX_I)

where

MCR = Total value of the import of consumption goods, deflated by PGDP,

GDPR = Real GDP,

P_PX_I = Relative domestic price vis-a-vis import price (here the export price of India is taken as proxy for overall import price index),

EXSD1 = SDR-exchange rate vis-a-vis Nepalese rupees,

TXMR = Import tax rate

MDVR = Total value of the import of development goods, deflated by PGDP, and

IGROSR = Total investment expenditure deflated by PGDP.

Exports

At a macro level, it is customary to assume that for a small country like Nepal, exports are more or less exogenously determined. Small countries are usually price-takers in international trade. It is for this reason that many macroeconomic models for developing countries take exports as exogenous to the system [Glower, 1982; Norton and Rhee, 1981; Narasimham, 1956].

Norton and Rhee [1981] treat exports as exogenous in a different way--a certain target rate of export growth is postulated that the country (South Korea) would achieve, and all the relevant policy instruments are geared toward achieving this particular export target. In this case, export is more a policy variable, determined outside the system. Indeed, in most models, exports are usually "thought to be totally unrelated to the domestic activity, since they depend on income of other countries" [Evans, 1969:222].

In the long run, small countries may be price-takers in the world market. Yet "in the short run, various disequilibria may dominate"

[Glower, 1982:97], necessitating a modification of treating exports as completely exogenous. This situation is usually accounted for in the literature in two ways. First, exports, like imports, can be considered to depend upon relative prices, so that the price of domestic goods and services produced for exports, relative to the price of other countries' goods, becomes an important explanatory variable in the export function. Secondly, changes in the home country's GNP and domestic import affect exports and GNP of other countries with which it trades. This may, in turn, affect the home country's export [Evans, 1969]. However, this seems valid only for big countries with monopoly power in trade and certainly not for a country like Nepal.

An attempt was made in the present study to present an endogenous explanation of exports, disaggregated into food and nonfood categories. However, the effort had to be abandoned because no theoretically plausible results could be obtained. Thus, it will be seen that the model presented in this study does not contain any export function. The export of food enters the model only as an exogenous variable.

Government

In most macroeconomic models for developed countries, government operation is often treated as exogenous or independent of current economic activity. However, the treatment of government receipts and expenditures separately "has the advantage that, in any integrated description of the economy, it is possible to assess the impact of government fiscal actions endogenously" [Pani, 1977:156]. Especially in most developing countries like Nepal, where government is found to take an active role in the process of economic development, the link

between government operations and economic activity is generally emphasized through fiscal operations and/or expenditure programs. For instance, it is generally emphasized that there is an important need to recognize the link between government operations and money creation with its direct effects on prices and incomes, including the interest rate [Pani, 1977]. This is particularly pronounced in view of the fact that the government seeks to balance its budget by deficit financing with additional money creation, with all its ensuing inflationary effects on the economy. Within the country, this calls forth a more careful investigation of the role of the monetary sector, reflecting on the whole the interlinkages between monetary and real sectors.

Taxes

Most models seek to incorporate government behavior through a system of tax equations [Narasimham, 1956; Glower, 1982; UNCTAD, 1968; Marwah, 1969a; Ali et al., 1977; Behrman and Klein, 1970; Evans, 1970]. It is generally recognized that tax revenue is mainly dependent upon private income/expenditures (transactions) or trade accounts, and hence could be related to the level of economic activity. Therefore, it is sensible to postulate that the amount of taxes received is endogenous. In the absence of a credible economic theory of the state, tax rate is often postulated to be exogenous [Glower, 1982; Pani, 1977; Evans, 1969]. It may, however, be noted that more authors have recently recognized the need for endogenizing government behavior, e.g., Schuh argues that

> The evidence we have on the responsiveness of policy to changing economic conditions also suggests that government can no longer be treated as exogenous, but must be treated as endogenous to the economy. [Schuh, 1981:97]

Some authors have sought to endogenize government behavior, e.g., Quezada-Salcedo [1981] seeks to explain it in terms of demand and supply of particular economic policy in a politico-economic framework. Pani [1977] relates tax rates to the level of desired investment by the government, assuming that as government intends to step up investment it generally raises tax rates. However, within the bounds of existing literature, the economic theory of the state is far from being well developed. So, it was not possible to fully endogenize government behavior. Hence, the exogeneity of government behavior with respect to the tax rate was recognized in the present model.

Taxes, both direct and indirect, are essentially the function of tax base and effective tax rate. It is conventional in the literature to take private consumption and national income, respectively, as tax bases for indirect tax and direct tax [Ali et al., 1977]. Some models do not make similar disaggregation [UNCTAD, 1968; Mammen, 1967], while still others do not include even one tax function [Marwah, 1969a].[11]

In the present model, indirect taxes were considered to be dependent upon gross domestic product, total imports, and the import tax rate. In the Nepalese context, it is well recognized that the

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[11] Besides an endogenous explanation of direct and indirect tax revenues in the traditional sense, some models, a la models for developed countries, emphasize a separate tax function related to Social Security since the tax revenue determination in this case is very different from what one could expect for others. For instance, Ali et al. [1977] hypothesizd that the Social Security tax was dependent on the wage bill and found good results for Tunisia. However, this hypothesis does not seem to apply in the case of Nepal.

import tax revenue forms an important share of total indirect tax receipts. Hence, total import and the import tax rate were included as arguments of the indirect tax function. Direct tax receipts were postulated to depend upon the tax rate and the gross domestic product in the nonagricultural sector.

Following the foregoing discussion, tax equations in the present model were specified as follows:

(4.5) TXIDRZ = F(GDPR, MR, TXMR)

where

TXIDRZ = Indirect tax revenue, deflated by PGDP,

GDPR = Real GDP,

MR = Total import expenditure, deflated by PGDP and

TXMR = Import tax rate.

(4.6) TXDRZ = F(GDPNAGR, TXDR)

where

TXDRZ = Total direct tax receipt, deflated by PGDP,

GDPNAGR = GDP in the nonagricultural sector, deflated by PGDP, and

TXDR = Direct tax rate.

Government Expenditures

For a complete picture of government operations, it is important to incorporate government expenditure behavior in the model in addition to the tax behavior. In the Nepalese context, the government is found to take a primary lead in boosting investment, not only by various indirect policy measures, but also direct investments.

As such, investment consideration is one of the most important factors in determining levels of government expenditure. Tax revenue is another determinant of the extent of governmental expenditure. In view of significant support of foreign aid in meeting investment needs, foreign aid was also included as a determinant of government expenditure, especially development expenditure, since it was mainly directed at investment expenditures.

Commensurate with the propositions made above, the government expenditure equations were specified as follows:

(4.7) GEXPDVR = F(IGROSRLG, FAIDR, TXR)

where

GEXPDVR = Government development expenditure, deflated by PGDP,

IGROSRLG = Lagged total gross investment (= Lag(IGROSR)) deflated by PGDP,

FAIDR = Foreign aid deflated by world GDP deflator, and

TXR = Total tax receipt, deflated by PGDP.

(4.8) GEXPRGR = F(GEXPRGRL, TXR)

where

GEXPRGR = Government regular expenditure deflated by PGDP,

GEXPRGRL = Lagged value of GEXPRGR, and

TXR = Total tax receipt, deflated by PGDP.

Supply

It was earlier recognized that, unlike the situation in developed industrial economies, where the lack of effective demand remains the principal reason for a fall in income and employment, there is a

greater need to incorporate the supply side in an essential manner in the macroeconomic model for developing economies like Nepal [Hansen, 1973; Behrman, 1974, 1975; Marwah, 1969a, b; Evans, 1969, 1970]. Needless to say, the choice of a particular sectoral output/supply function, including the structure, is a matter of judgment based on the purpose of the particular macro model. For example, in spite of the significant contribution the agricultural sector makes to GDP in India, Rangarajan [1982] chooses to keep agricultural output as exogenous, endogenizing the output of the industrial consumption good in his model. This is justified because the model is geared toward investigating the relationship between the agricultural sector and the non-agricultural sector, especially toward explaining what effects changes in the agricultural sector would have on the industrial sector. However, in the present case, since the object is to investigate not only how the rest of the economy responds to any changes in the agricultural sector, but also how the agricultural sector responds to various other agricultural and general economic policies, it is necessary, partially at least, to endogenize the agricultural sector. The agricultural sector constitutes a major share in total GDP, exports, and employment in the economy, and obviously, the level of response by the agricultural sector to any general economic policy constitutes the major share of response of the entire economy.

The construction of more developed production functions is very difficult to undertake in developing countries "in the absence of detailed comprehensive information on the work force, the number of hours worked, capacity utilization and all other related variables" [Marwah, 1969a:239]. More often, one has to be satisfied with a few

simple production relations, while in others where the data situation is still worse, only a few supply functions are specified [Hansen, 1973].

Although "in most macroeconometric models the general form of the output equations is in the form of an aggregate production function, i.e., output = F(capital, labor)" [Stephenson and Itharattana, 1977: 27], it is difficult to use this form of the function in the case of Nepal, mainly because of the lack of time series data on capital stock. In the Nepalese context, one could make use of mainly the data existing on investment and others, e.g., acreage, irrigation, etc., in the case of the agricultural sector. Therefore, what are specified as production equations in the present model are not aggregate production functions in the real sense of the term but are simply regression equations that attempt to predict the monetary value of output with respect to several input combinations.

Generally, the farmers' decision in allocating area between food grains and nonfood grains output is explained primarily along the Nerlovian adjustment process, viz., that the area planted depends upon relative prices and expected rainfall (see Pani [1977]). Then, through the second stage, one could relate output in food grains with total related-acreage, the actual rainfall and fertilizer inputs, besides irrigation facilities and the use of improved seed varieties. The acreage under nonfood agricultural output is often postulated to depend upon relative prices, total exports, and the output of manufacturing sector, since nonfood grains output goes mainly as raw materials to domestic manufacturing and export of agricultural output.

The lack of data on time series basis of variables mentioned above for the Nepalese economy hindered the specification of a more elaborate production function. Because of the lack of reliable data on irrigation on a continuing basis, it was not possible to introduce this variable in the present model. Data on rainfall were also very scanty. Accordingly, the production equation specified in the present model was as follows:

(4.9) GDPAGR = F(FERT, PAGPNAGL, XFR)

where

GDPAGR = Agricultural GDP, deflated by PGDP,

FERT = Level of fertilizer use,

PAGPNAGL = Lagged value of the relative agricultural price with respect to the nonagricultural price, and

XFR = Agricultural exports, mainly food exports, deflated by PGDP.

The output of the nonagricultural sector depends primarily on investment.[12] In the absence of a sizable capital goods sector, most investment goods have to be imported. Therefore, it is but logical that the import (or capability to import) of investment goods is one important determining factor of total investment in the economy. The sectoral price level itself is another factor that determines investment in the nonagricultural sector.

In view of the overwhelming size of the agricultural sector vis-a-vis the national economy and the heavy dependence of the

[12] Capital stock is indeed the main variable. However, in the absence of data on capital stock, it is customary to use investment data to approximate the effect of capital stock.

nonagricultural sector on agriculture--both for the market and investment purposes, the agricultural GDP itself is considered an important determinant of the nonagricultural GDP.

Based on the foregoing discussion, the equation for the nonagricultural GDP was proposed as follows in the model:

(4.10) GDPNAGR = F(IGROSRLG, PAGPNAGL, GDPAGR)

where

GDPNAGR = Nonagricultural GDP, deflated by PGDP,

IGROSRLG = Lagged value of IGROSR,

PAGPNAGL = Lagged value of the relative price of the agricultural sector vis-a-vis the non agricultural sector, and

GDPAGR = Agricultural GDP, deflated by PGDP.

Prices

Because prices are necessarily in money terms rather than real terms, most treatments in this area link together discussions of prices and money. The quantity theory (of money) provides such a direct link [Evans, 1970:290].

The demand for money in the classical model, especially spearheaded by Wicksell [1936], stems mainly from the quantity theory of money according to which $P \cdot Q = M \cdot V$, where P is price level, Q is total output, M is money supply, and V is velocity of circulation. Since V is usually institutionally fixed, $M/P = f(Q)$; i.e., real money demand is a function of total output or transaction.

However, especially since the advent of the Keynesian formulation which highlights the liquidity preference schedule with the speculative

demand for money occupying a prominent place, the demand for money was expressed in the following form:[13]

$$M = k \cdot P \cdot Q + \lambda \cdot P \cdot i,$$

or writing it in terms of real cash balances,

$$M/P = k \cdot Q + \lambda \cdot i,$$

where

i = rate of interest,

M = demand for money,

Q = output, and

P = price level.

Indeed, according to Wicksell [1936] (and reformulated by Patinkin),[14] the rate of interest is determined by the money stock at full employment. Changes in the money stock will be reflected entirely in the changes in the price level. This is, of course, the primary claim of the quantity theorists. However, even the advocates of this theory claim that this is a long run equilibrium position. In the short run,

> Where adjustments from one equilibrium position to another are occurring, and inflexible product and factor prices exist, there is little question that tightening of the money supply does raise interest rates. In fact, this is the primary purpose of monetary policy. . . . [Evans, 1970: 311]

especially for dealing with cyclical movements in the developed industrial countries. Especially in developing countries like Nepal

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[13] See Evans [1970:30].

[14] See Don Patinkin [1965], Money, Interest and Price.

where the rate of interest is often directly regulated by the government, the relationship between the money stock and prices is found to be more direct and pronounced.

It is more common and realistic in most developing countries, particularly in view of existing wide-ranging market imperfections and government intervention over firms and industries, to assume largely a mark-up pricing[15] for industries, especially along the Kalecki model [Taylor, 1979:51]. Even Keynes wrote,

> In a single industry its particular price-level depends partly on the rate of remuneration of the factors of production which enter into its marginal cost, and partly on the scale of output. There is no reason to modify this conclusion when we pass to industry as a whole. [1936: 294]

This pricing approach is usually considered a more realistic description of the nonagricultural sector. However, normally "agricultural firms do not individually determine the price of their products in the usual terms. They are price takers, not price makers" [Evans, 1970: 291].

On the basis of the foregoing discussion, it is reasonable to assume that the price in the agricultural sector depends upon agricultural output and the supply of money. In order to highlight the proximity and interlinkages of the Nepalese agriculture, especially the food market with its neighboring Indian markets, it is reasonable to include the import price of food in India as an influencing variable. Accordingly, the equations for prices have been specified as follows:

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[15] For instance, prices of firms in regulated industries, of course with some market imperfections, are set so as to result in the normal rate of return (see Taylor [1979]).

(4.11) PAG = F(QAG, M1, PMF_I)

where

PAG = Agricultural price in index number (1964-65 = 100),

QAG = Agricultural production in index number (1964-65 = 100),

PMF_I = Import price of food in India (1964-65 = 100), and

M1 = Total money supply (cash and demand deposits).

(4.12) PNAG = F(PAG, GDPNAGR)

where

PNAG = Nonagricultural prices in index number (1964-65 = 100),

PAG = Agricultural price (as above), and

GDPNAGR = Nonagricultural GDP, deflated by PGDP.

The agricultural price was introduced as an argument in the equation for the nonagricultural price in view of the preponderance of the agricultural sector in the economy.

Money

Conventionally, the supply of money is usually treated as exogenous to the system (see Keynes [1936] and Evans [1970]). However, it is generally accepted [Klein, 1968; Behrman, 1975; Nugent, 1975], especially for developing countries, that the supply of money cannot be treated as exogenous, not only because government budget deficits are reflected in additional supply of money but also because

governments often follow an "assymetrical sterilization policy"[16] [Black, 1981:46].

Also, in most economies seeking to step up the rate of domestic investment in the economy, it is often reasonably postulated that government's budgetary deficits are reflected in additional money creation.[17]

In the Nepalese context, it is generally recognized that foreign aid also has an important role in augmenting money supply. This result is primarily because of two reasons: (1) foreign aid usually helps to improve the foreign exchange (international reserve) position, and (2) usually the availability of foreign aid is often conditional upon raising matching domestic investment funds which are met by measures such as the government budgetary deficit.

In consonance with what has been discussed above, the equation for money supply in the present model was specified as follows:

(4.13) $M1 = f(GBDF2, FAID, IRESV)$

where

M1 = Money supply,

GBDF2 = Government budgetary deficit (expenditure minus revenue),

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[16]Usually monetary expansion is caused by assymetrical sterilization policy: nonsterilization of reserve inflows but sterilization of outflows. That is, increased reserves are not offset by restrictive monetary policy, but decreased reserves are offset by expansionary monetary policies that keep reserve contraction from reducing the money supply. (See also, Cline and Weinstraub [1981], especially page 9.)

[17]This is also reinforced by the lack of a well developed domestic money market.

FAID = Total nominal foreign aid, and

IRESV = International reserve.

Based upon the foregoing discussion, the equations of the present model were specified as in Table 13. The first 13 equations are behavioral equations, and the remaining four are identities.

Table 13. The model

1.	CPR = f(GDPR, CPRLAG)
2.	IGROSR = f(GEXPDVR, GDPRCHNG)
3.	MCR = f(GDPR, P_PX_I, EXSD1, TXMR)
4.	MDVR = f(IGROSR, P_PX_I)
5.	TXIDRZ = f(GDPR, MR, TXMR)
6.	TXDRZ = f(GDPNAGR, TXDR)
7.	GEXPDVR = f(IGROSRLG, FAIDR, TXR)
8.	GEXPRGR = f(GEXPRGRL, TXR)
9.	GDPAGR = f(FERT, PAGPNAGL, XFR)
10.	GDPNAGR = f(IGROSRLG, PAGPNAGL, GDPAGR)
11.	PAG = f(QAG, M1, PMF_I)
12.	PNAG = f(PAG, GDPNAGR)
13.	M1 = f(IRESV, GBDF2, FAID)
14.	PGDP = 0.63 PAG + 0.37 PNAG
15.	MR = MCR + MDVR
16.	TXR = TXIDRZ + TXDRZ
17.	GDPR = GDPAGR + GDPNAGR

CHAPTER V
EMPIRICAL ESTIMATION OF THE MODEL

This chapter presents a discussion about the estimation procedure and the results of the individual estimated equations of the model in the study.

Estimation Procedure of the Model

A problem in the estimation of the macroeconometric model in the present study was that of an undersized sample. That is, the number of observations was less than the number of exogenous variables. In such a situation, the sample moment matrix does not have an inverse, and ordinary least square gives estimates which are inconsistent except when the system is recursive. There are several ways in which an analyst may obtain estimates with an undersized sample. One such method is by using "maximum entropy" moments [Theil, 1982]. Although the inverse of the sample moment matrix does not exist for undersized samples, the maximum entropy moments always exist and through the use of maximum entropy moments, point estimates of the parameters may be obtained.

Another method, employed to deal with the problem of undersized samples, is the use of the method of "principal components" [Evans, 1970]. This is the method used in the present study.

In order to avoid the potential problem of having to use too many principle components against the limited number of observations, the

"truncated two stage least square" [Brundy and Jorgenson, 1971] was employed in the estimation of the present model.

The justification for the use of principal components of the predetermined variables as their instruments is that the first $j < q$ (where j = the number of principal components used and q = the sample size) principal components capture much of the variation in the full set of predetermined variables. Hence, the principal components "appear to provide an ingenious way of eliminating very little information from X (the predetermined variables), while significantly reducing the size of the estimation problem" [Brundy and Jorgenson, 1974:688].

The number of principal components used (j) in the estimation of the model is the square root of the number of observations ($=\sqrt{n}$, where "n" is the number of observations). This ensures that as $n \to \infty$, $j \to \infty$, preserving the property of consistency. The number of principal components used in the present model was four, approximately the square root of 17--the number of observations. These first four principal components used explained 90.3% of the total variations in the exogenous variables in the model.

It is a common practice in the literature to estimate the instruments for the endogenous variables at the first stage of the "two stage least square" by regressing the endogenous variables on the principal components. However, it has been demonstrated that such estimates are inconsistent [Brundy and Jorgenson, 1971]. It is possible to obtain consistent estimates by regressing each endogenous variable on the principal components as well as the exogenous variables contained in the individual equation related to that

particular endogenous variable (see [Brundy and Jorgenson, 1974] for a discussion about the property of consistency of such estimates). This methodology has been used in the present study.

Estimated Equations of the Model

The overall results of the truncated two stage least square (2SLS) analysis of the present model are given in Table 14. It can be seen that, in general, results of the results are encouraging. In most cases, the parameters have the signs and general levels which economic theory and results from other empirical works would suggest.

The Consumption Equation

$$(5.1) \qquad \underset{}{CPR} = \underset{(904.317)}{-914.339} + \underset{(0.366)}{0.643}\ GDPR + \underset{(0.327)}{0.413}\ CPRLAG$$

The estimated consumption equation has the signs which were theoretically expected. The marginal propensity to consume is 0.64. At the first instance, it may appear that this value looks much lower than what one would expect, say in the range of 0.80 to 0.90.[2] However, consumption, CPR, in the present model includes not only private consumption but also government consumption.[3] Since the

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[1] Figures in the parentheses are standard errors of the corresponding parameters.

[2] See Glower [1982], Evans [1970], and Marwah [1969a].

[3] Private consumption and government consumption were combined because of absence of time series data of private consumption in Nepal. Theoretically, consumption function is better made to reflect the relationship between private consumption and national income.

Table 14. Estimated equations of the model

1. CPR = -914.339 + 0.643 GDPR + 0.413 CPRLAG
(904.317) (0.366) (0.327)

2. IGROSR = -124.997 + 1.715 GEXPDVR + 0.104 GDPRCHNG
(65.448) (0.117) (0.122)

3. MCR = -846.496 + 0.193 GDPR + 291.431 P_PX_I - 8.325 EXSD1
(342.327) (0.056) (197.369) (15.511)

- 15.395 TXMR
(3.883)

4. MDVR = -92.406 + 0.392 IGROSR + 196.305 P_PX_I
(168.531) (0.056) (207.773)

5. TXIDRZ = -862.200 + 0.117 GDPR + 0.164 MR + 5.656 TXMR
(112.057) (0.030) (0.088) (3.404)

6. TXDRZ = -83.935 + 0.031 GDPNAGR + 27.137 TXDR
(6.531) (0.002) (1.535)

7. GEXPDVR = -70.033 + 0.151 IGROSRLG + 0.333 FAIDR + 1.010 TXR
(32.821) (0.062) (0.298) (0.134)

8. GEXPRGR = -2.643 + 0.230 GEXPRGRL + 0.556 TXR
(16.499) (0.277) (0.194)

9. GDPAGR = 2963.133 + 0.037 FERT + 1557.097 PAGPNAGL + 0.444 XFR
(1215.706) (0.010) (1180.896) (1.083)

10. GDPNAGR = -875.323 + 0.503 IGROSRLG - 3577.660 PAGPNAGL
(2764.242) (0.747) (4327.635)

+ 1.387 GDPAGR
(1.267)

Table 14. Continued

11.	PAG =	-0.110 + 0.926 QAG + 0.0002 M1 + 0.185 PMF_I (0.654) (0.649) (0.0002) (0.062)
12.	PNAG =	0.049 + 0.839 PAG + 0.00003 GDPNAGR (0.130) (0.080) (0.0001)
13.	M1 =	30.474 + 0.005 IRESV - 0.838 GBDF2 + 0.550 FAID (93.884) (0.001) (0.257) (0.240)
14.	PGDP =	0.63 PAG + 0.37 PNAG
15.	MR =	MCR + MDVR
16.	TXR =	TXIDRZ + TXDRZ
17.	GDPR =	GDPAGR + GDPNAGR

* Figures in the parantheses indicate standard errors.

propensity to consume by the government is usually far less than that with respect to private consumption, the estimated value of the propensity to consume, at 0.64, could well be considered realistic. The lagged value of consumption also seems to have significant effect on current consumption. This result captures the spirit of the permanent[4] income hypothesis.

The Investment Equation

(5.2) IGROSR = -124.997 + 1.715 GEXPDVR + 0.104 GDPRCHNG
(65.448) (0.117) (0.122)

The parameters of the estimated investment equation have the expected signs. Government development expenditure seems to have significant effect on the level of investment. For a million rupees of development expenditure, the level of investment achieved is RS 1.72 million.

Import Equations

(5.3) MCR = -846.496 + 0.193 GDPR + 291.431 P_PX_I - 8.325 EXSD1
(342.327) (0.056) (197.369) (15.511)

- 15.395 TXMR
(3.883)

(5.4) MDVR = -92.405 + 0.392 IGROSR + 196.305 P_PX_I
(168.531) (0.056) (207.773)

[4] As mentioned in an earlier section, it is customary to include lagged value of consumption as an explanatory variable in the consumption function in order to account for the effect of "permanent income" (see Evans [1969:49].

Two equations, one for the import of consumer goods (MCR) and the other for the import of development goods (MDVR) were estimated as given above. In both cases, the coefficients were found to conform to theoretical expectations, in signs and at appropriate levels. For instance, in the case of the import of consumer goods equation, the import of consumer goods is found to depend positively on the gross domestic product; i.e., as GDP increases, imports rise too. Also, as the domestic price (P) rises relatively with respect to export price of India (PX_I), the import of consumer goods rises. On the other hand, as the exchange rate increases, i.e., foreign currency gets more expensive vis-a-vis domestic currency, imports fall.

It could be seen that, at their mean values, the elasticity of the import of consumer goods (MCR) with respect to the relative domestic price relative to Indian export price (P_PX_I) is 0.41. That is, as the domestic price increases by 1% relative to the Indian export price, the import of consumer goods increases by 0.41%. Similarly, a 1% increase in the import tax leads to 0.58% fall in the import of consumer goods, calculated at the mean values.

The import of development goods increases as investment (total gross investment) increases. An increase of 1 million rupees in investment in the economy is found to increase the import of development goods by Rs 0.392 million. As P_PX_I, the domestic general price relative to the Indian export price, increases by 1% the import of development goods is expected to increase by 0.42%, again at the means of the data.

Equations for Taxes

(5.5) TX1DRZ = -862.200 + 0.117 GDPR + 0.164 MR + 5.656 TXMR
(112.057) (0.030) (0.088) (3.404)

(5.6) TXDRZ = -83.934 + 0.031 GDPNAGR + 27.137 TXDR
(6.531) (0.002) (1.535)

The signs and coefficients of both tax equations conform to theoretical expectations. Total indirect tax (TX1DRZ) is found to depend positively upon GDPR; total imports, and the tax rate on imports. With respect to the tax rate on imports (TXMR), it could be observed that as this tax rate increases, it has a positive effect on tax proceeds. The estimated elasticity of TX1DRZ with respect the import tax rate (TXMR) at the means of the data was 0.11. That is, a 1% increase in TXMR increases indirect tax proceeds by 0.11%.

Total proceeds from direct taxes (TXDRZ) increased as the non-agricultural GDP (GDPNAGR) and the tax rate itself (TXDR) increased--conforming again to theoretical expections. A 1 million rupee increase in GDPNAGR increased TXDRZ by 0.03 million rupees. The estimated elasticity of the direct tax proceeds (TXDRZ) with respect to the direct tax rate itself (TXDR) at the means of the data was 1.01. That is, a 1% increase in the direct tax rate increased total direct tax proceeds by 1.01%, which is close to unity.

Equations for Government Expenditures

Government Development Expenditure Equation

$$(5.7) \quad GEXPDVR = \underset{(32.821)}{-70.032} + \underset{(0.062)}{0.151}\ IGROSRLG + \underset{(0.298)}{0.333}\ FAIDR + \underset{(0.134)}{1.010}\ TXR$$

The equation for the government development expenditure bear the signs which were theoretically expected. The development expenditure was found to depend positively on lagged gross investment, foreign aid and total tax receipts. A 1 million rupee increase in foreign aid (FAIDR) increased the government development expenditure (GEXPDVR) by 0.33 million. On the other hand, a 1 million rupees increase in total taxes (TXR) increases GEXPDVR by a little more than 1 million rupees (1.01 million rupees). A 1 million increase in TXR produced about three times the increase in GEXPDVR as did a similar increase in FAIDR.

Government Regular Expenditure Equation

$$(5.8) \quad GEXPRGR = \underset{(16.499)}{-2.643} + \underset{(0.277)}{0.230}\ GEXPRGRL + \underset{(0.194)}{0.556}\ TXR$$

The estimated equation for the government regular expenditure (GEXPRGR) have the expected signs. The government regular expenditure was found to depend positively with its lagged value (GEXPRGRL) and total tax receipts (TXR). A 1 million rupee increase in total tax proceeds, TXR, increased the government regular expenditure by 0.556 million.

The Equation for Agricultural GDP

$$(5.9) \quad \underset{}{GDPAGR} = \underset{(1215.706)}{2963.133} + \underset{(0.010)}{0.037}\ FERT + \underset{(1180.896)}{1557.097}\ PAGPNAGL + \underset{(1.083)}{0.444}\ XFR$$

The estimated equation for agricultural GDP had parameters with expected signs. Agricultural GDP increased by 0.444 million rupees as agricultural export, XFR, increased by Rs 1 million. Similarly, as the consumption of fertilizer increased by 1,000 tons, agricultural GDP at 1964-65 prices, GDPAGR, increased by 0.037 million rupees. As the lagged relative agricultural prices, PAGPNAGL, relative to the non-agricultural price, increases by 1%, the agricultural GDP, GDPAGR, increased by an estimated 0.33% at the means of the data.

The Equation for the Nonagricultural GDP

The equation for nonagricultural GDP also has its parameters with theoretically expected signs as given below:

$$(5.10) \quad \underset{}{GDPNAGR} = \underset{(2764.242)}{-875.323} + \underset{(0.747)}{0.503}\ IGROSRLG - \underset{(4327.635)}{3577.660}\ PAGPNAGL + \underset{(1.267)}{1.387}\ GDPAGR$$

The agricultural GDP has an estimated positive effect on the nonagricultural GDP; e.g., the effect of Rs 1 million increase in the agricultural GDP could result in an estimated increase of Rs 1.387 million in the nonagricultural GDP. A 1% increase in the lagged relative agricultural price, relative to the nonagricultural price,

(PAGPNAGL) had an estimated effect of a decrease of 1.43% in the non-agricultural GDP (GDPNAGR) the next year.

Equations for Prices

(5.11) PAG = -0.110 + 0.926 QAG + 0.0002 M1 + 0.185 PMF_I
(0.654) (0.649) (0.0002) (0.062)

(5.12) PNAG = 0.049 + 0.839 PAG + 0.00003 GDPNAGR
(0.130) (0.080) (0.0001)

Equation (5.11) is the equation for the agricultural price. It could be observed that it takes the character of a supply equation, for the price and the quantity are positively related. In this connection, it is important to bear in mind that the individual equations merely reflect the relationship of the endogenous variables and the exogenous variables without strictly being either a demand equation or a supply equation. Rather it represents an equilibrium price and depends on both supply and demand parameters.

There is a positive relationship between the agricultural price and production (QAG). And the estimated elasticity of the agricultural price with respect to the agricultural production index (1964-65 = 100) was 0.36. At the mean values, a 1 percent increase in the Indian import price of agricultural products had an effect of an estimated increase of 0.36% in the agricultural price in Nepal (PAG).

There is a positive relationship between money supply and the agricultural price. The estimated effect of an increase in money supply is increase the agricultural price. At the mean values, the

estimated elasticity of the agricultural price with respect to the money supply was 0.14.

The parameters in the equation for the nonagriculture price (PNAG) have the expected signs. The nonagricultural price was estimated to increase with an increase in the agricultural price and was inversely related to GDP in the nonagricultural sector (GDPNAGR). Calculated at the mean values, the estimated elasticity of PNAG with respect to PAG is 0.77. That is, a 1% increase in the agricultural price increases the nonagricultural price by 0.77%. Similarly, the elasticity of PNAG with respect to GDPNAGR was found to be 0.05.

The Equation for Money Supply

$$(5.13) \quad M1 = \underset{(93.884)}{30.474} + \underset{(0.001)}{0.005}\ IRESV - \underset{(0.257)}{0.838}\ GBDF2 + \underset{(0.240)}{0.550}\ FAID$$

The equation for money supply given above had parameters with theoretically expected signs. Money supply rose with a rise in international reserve (IRESV), the government budgetary deficit (-GBDF2), and foreign aid (FAID). The estimated parameters measuring the effect of government budgetary deficit and foreign aid had estimated standard errors considerably smaller than the estimated parameters. A 1 million rupees increase in the government deficit increased money supply by 0.84 million rupees. Similarly, an increase of Rs 1 million in foreign aid (FAID) had the effect of increasing money supply by RS 0.55 million.

Alternate Estimation of the Model

The discussion thus far has been based upon the truncated two stage least square method of estimation of the simultaneous equations system. An alternate estimation of the model based upon a truncated three stage least square[5] method of estimation is also presented in Appendix B. Most of the parameters of the model, in general, maintained theoretically expected signs (Table B-1).

[5] The "Three Stage Least Square" (3SLS) is a system method of estimation.

CHAPTER VI
EVALUATION OF THE MODEL

This chapter reports an attempt to evaluate how the estimated macroeconometric model performed in capturing the actual course of events of the Nepalese economy over the period of study. For this evaluation the exogenous variables were taken as given and the endogenous variables predicted.

An attempt was first made of the "within the sample period simulation," comparing the actual values of the endogenous variables with the estimated values of the corresponding variables year by year. Both the actual and the estimated values of the endogenous variables were plotted against time (year). The "Root Mean Square" (RMS) criterion was employed in order to determine the "accuracy" of the model. The "RMS" was defined as the square root of the sum of squared residuals divided by the number of observations, i.e.,

$$RMS = \sqrt{\sum_{i}^{N} \frac{(P - A)^2}{N}}$$

where

P represents the predicted values of an endogenous variable,

A represents the actual value of the endogenous variable, and

N represents the number of years.

Besides the "RMS" error, the "RMS" percent error is also calculated. These values are given in Table 15.

If a critical value were set to be 20%, then the "RMS" percent errors of all the variables, except MDVR, import of development goods, fall within the critical value. If the critical value were set at 15%, only one more equation, corresponding to TX1DRZ (total indirect tax) has the "RMS" percent error higher than the critical level. Thus, on the whole, the performance of our model could be considered as reasonably satisfactory on the basis of the performance of the model on "RMS" percent error criterion.

The estimated and the actual value of the endogenous variables were plotted against time. The graphical result demonstrates that the model performed fairly well in tracking the actual course of events of the Nepalese economy—particularly the pattern and extent of changes in the endogenous variables in most of the years.

Sample Period Simulation of Endogenous Variables

Consumption

For the consumption simulation, the "RMS" prediction error was 3.44%. This estimate suggests that the predicted values of the variable, CPR, did not deviate much from the actual values within the sample period. The directions of change of the predicted values and the observed values of the variable run fairly close in most years, except in 1966-67 and 1977-78 as shown in Figure 1. In these two years, the model failed to predict the directions of the actual changes in the variable.

Table 15. Root mean square (RMS) and percentage RMS errors for equations in the model

Variable	"RMS" error	"RMS" percent error
CPR	227.204	3.444
IGROSR	114.417	13.271
MCR	49.956	10.828
MDVR	62.659	27.983
TXIDRZ	28.135	17.094
TXDRZ	6.847	7.196
GEXPDVR	54.184	13.227
GEXPRGR	26.264	11.241
GDPAGR	221.341	4.335
GDPNAGR	197.157	7.346
PAG	0.112	6.467
PNAG	0.081	4.948
M1	88.894	9.871
PGDP	0.095	5.684
MR	75.409	11.867
TXR	32.802	12.453
GDPR	211.624	2.919

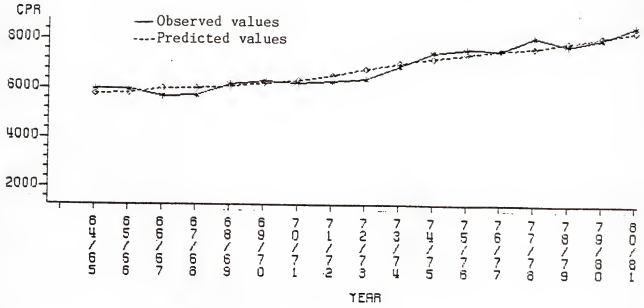

Figure 1. Simulation of consumption

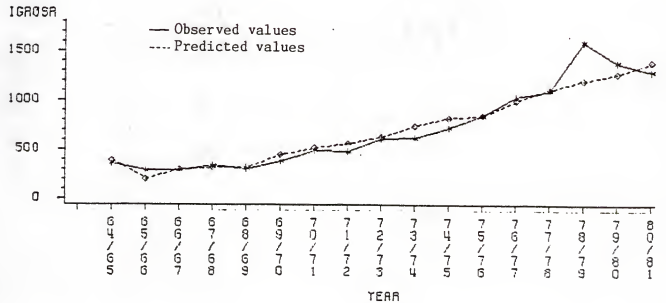

Figure 2. Simulation of investment

Investment

The "RMS" percent error for the simulation of gross investment, IGROSR, was at 13.27%--a value much higher than that for consumption, yet is well below a critical level set at 20%. The direction of change in the predicted value of the variable, IGROSR, was noticeably different from its observed value only in 1973-74 and 1979-80 (Figure 2). The investment equation captured the magnitude and direction of the change in gross investment in the economy within the period of study reasonably well.

Import of Consumer Goods

For the equation of the import of consumer goods (MCR), the "RMS" percent error was 10.83%--considerably below a critical level at 20%. The direction of change of the predicted value of MCR follows very closely the observed values except in 1970-71 and 1973-74 (Figure 3).

Import of Development Goods

The equation of import of development goods (MDVR) performed worst in the "validation" results of the model. The "RMS" percent error with respect to MDVR, was 27.98%, and above a critical level of 20%. The direction of change of the estimated values of MDVR was different from the observed values in five years, 1967-68, 1968-69, 1969-70, 1970-71 and 1973-74 (Figure 4). The observed values of MDVR shows more variability than the predicted values.

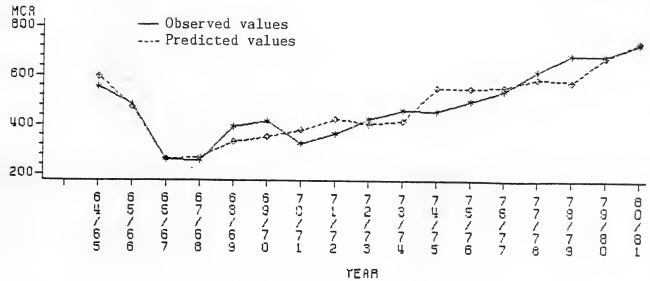

Figure 3. Simulation of consumption goods imports

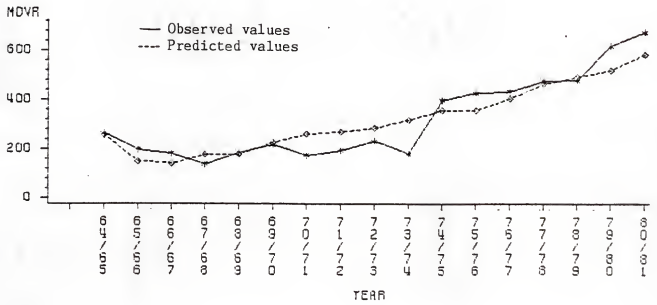

Figure 4. Simulation of development goods imports

Total Imports

Although MDVR, a component[1] of total imports (MR), displayed a significantly higher "RMS" percent error than the critical value at 20%, MR itself had a lower "RMS" percent error of 11.86%. With the exception of 1970-71 and 1975-76, the direction of change of the predicted values of MR closely followed the observed values (Figure 5). The variabilities in the predicted and actual values were similar.

Indirect Tax

The "RMS" percent error for the simulation of the indirect tax proceeds, TXIDRZ, was 17.09--less than the critical value at 20%. The predicted values TX1DRZ followed quite closely the observed values (Figure 6). The direction of change in the predicted values closely followed the direction for the observed values except in 1979-80. The equation for the indirect tax proceeds captured the magnitude and direction of change in the indirect tax returns reasonably well.

Direct Tax

The "RMS" percent error for direct tax revenue (TXDRZ) was 7.20%. With the exception of 1972-73, the model tracked fairly well the direction of change in the observed values of direct tax revenue (Figure 7).

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[1] MR = MDVR + MCR.

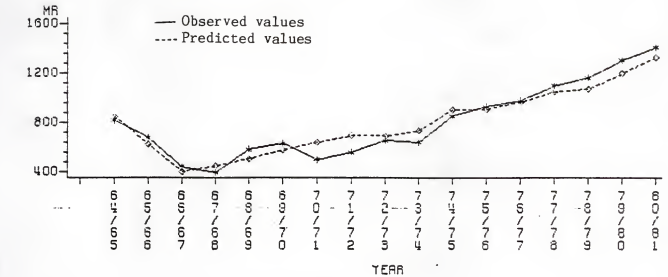

Figure 5. Simulation of total imports

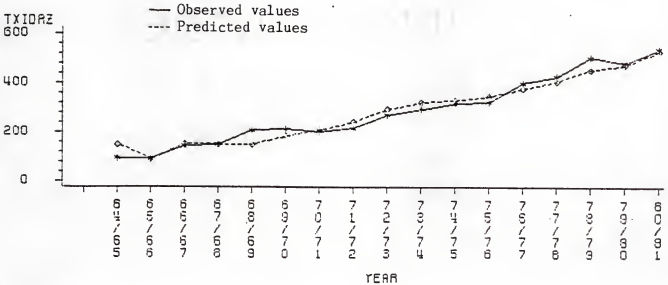

Figure 6. Simulation of indirect tax revenue

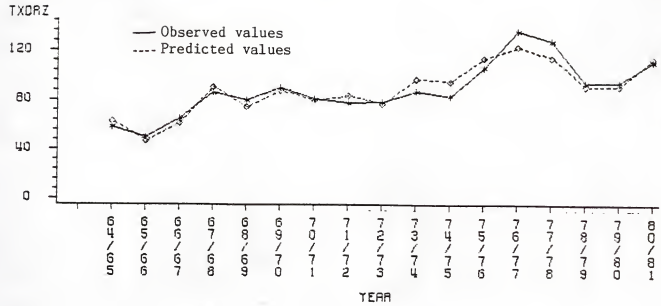

Figure 7. Simulation of direct tax revenue

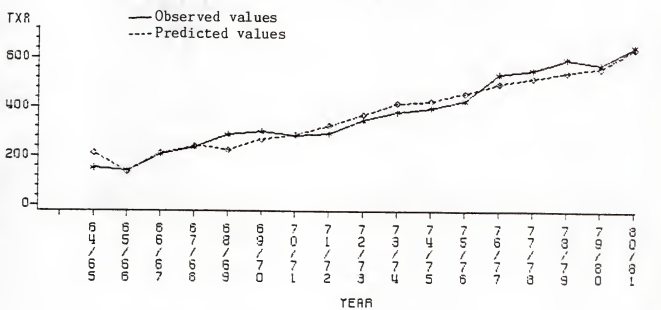

Figure 8. Simulation of total tax revenue

Total Tax

The model tracked the direction of change in TXR correctly in all the years except 1979-80 (Figure 8). The "RMS" percent error for total taxes was 12.45%.

Government Development Expenditure

The "RMS" percent error for the simulation of government development expenditure (GEXPDVR) was 13.23%. Except in 1965-66 and 1968-69, the model correctly tracked the direction of the change in the value of GEXPDVR (Figure 9). The model correctly predicted the graduated increase in the level of government development expenditure after 1968-69. These are illustrated in Figure 9.

Government Regular Expenditure

The "RMS" percent error with respect to government regular expenditure (GEXPRGR) was 11.24%. The model "predicted" the wrong directions of change of the value of GEXPRGR in four years, 1965-66, 1967-68, 1971-72 and 1977-78. The observed values of GEXPRGR showed much more variability than the predicted ones. Yet the "RMS" percent error with respect to this variable remained well within a critical level of 20%. The plots of the observed and predicted value or GEXPGRG, are given in Figure 10.

Agricultural GDP

As it was in the case of government regular expenditure (GEXPRGR), the predicted values of the agricultural GDP (GDPAGR) displays much

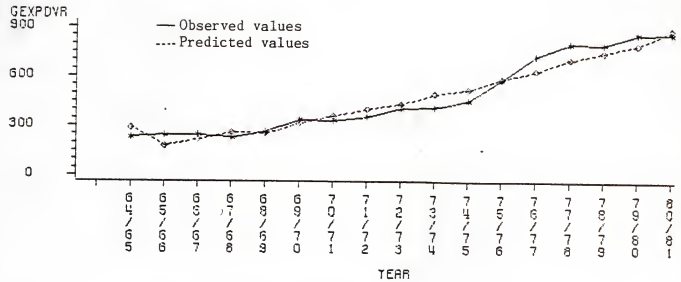

Figure 9. Simulation of government development expenditure

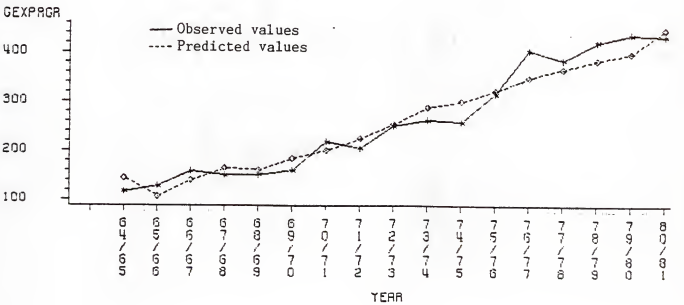

Figure 10. Simulation of government regular expenditure

more variability than its actual values. The "RMS" percent error was 4.34%. The model failed to predict the actual direction of change of the values of GDPAGR in 1966-67, 1972-73, 1973-74, 1975-76 and 1979-80 (Figure 11).

Nonagricultural GDP

The predicted values of nonagricultural GDP, GDPNAGR, displayed less variability than observed values (Figure 12). In three years, 1972-72, 1973-74 and 1980-81, the model predicted wrong directions of change of the values of GDPNAGR. The "RMS" percent error of nonagricultural GDP, GDPNAGR, was 7.35%.

Gross Domestic Product

The gross domestic product, GDPR, equation had the lowest "RMS" percent error of 2.92%. The predicted values captured both the extent and direction of variations in the observed value of GDPR. Predicted values run close to the actual values in most years (Figure 13).

Agricultural Price

The paths of agricultural price (PAG) are presented in Figure 14. Except in 1972-73, the model predicted correct directions of change of PAG for all years. Variations in the predicted values of PAG seemed to closely follow the observed values. The "RMS" percent error with respect to PAG was 6.47%.

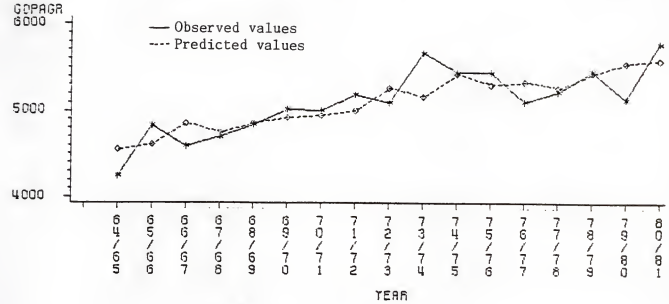

Figure 11. Simulation of agricultural GDP

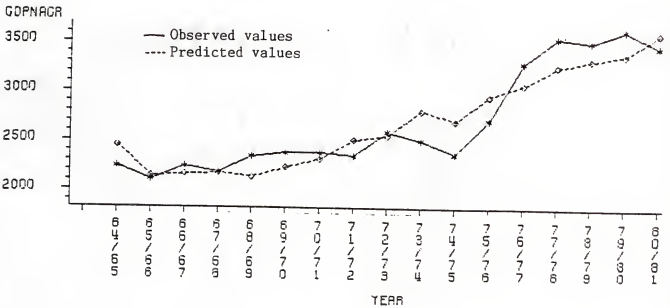

Figure 12. Simulation of nonagricultural GDP

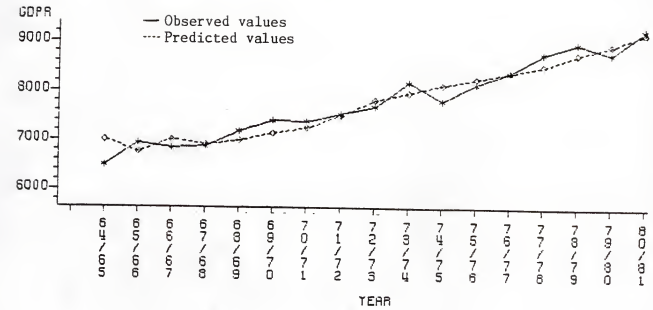

Figure 13. Simulation of GDP

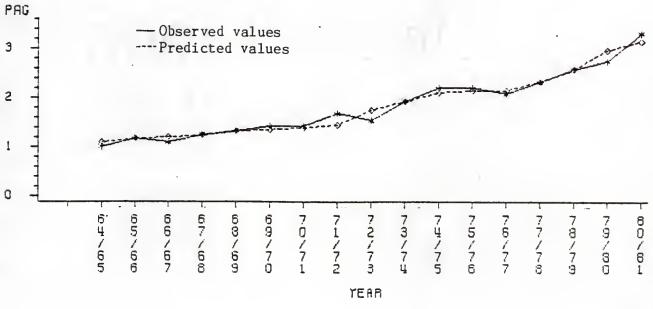

Figure 14. Simulation of agricultural price

Nonagricultural Price

The "RMS" percent error of the nonagricultural price (PNAG) was 4.95%. The path of the predicted values of PNAG closely followed that of the observed values (Figure 15). Only in one year, 1972-73, did the model fail to predict the direction of change of the observed value of PNAG.

GDP Deflator

The model captured the levels and variability in the values of the GDP deflator (PGDP). The model performed well in predicting the direction of change in the values of PGDP except in 1976-77 (Figure 16). The "RMS" percent error with respect to PGDP was 5.68%.

Money Supply

The model performed well in tracking the money supply, M1 (Figure 17). The model did not make any wrong predictions in the direction of movement of actual values of M1. The "RMS" percent error for M1 was 9.85%.

Simulation of the Model under 3SLS

A "within the sample period simulation" was run for the 3SLS model too. The alternate model did not perform so well as it did in the previous case (using the 2SLS estimation procedure) on the basis of "RMS" percent errors (Table B-2).

The "RMS" percent error with respect to each of the equation increased, vis-a-vis the pervious model, based upon the truncated

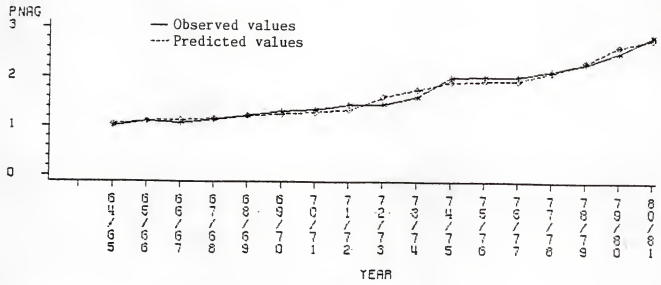

Figure 15. Simulation of nonagricultural price

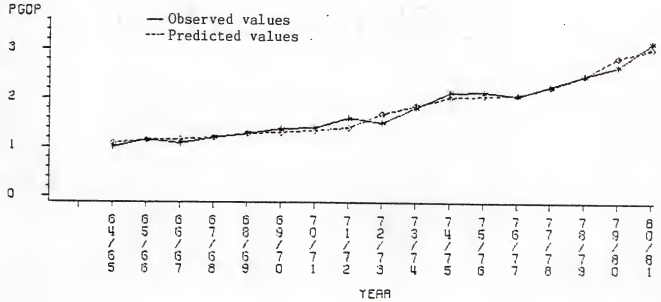

Figure 16. Simulation of GDP deflator

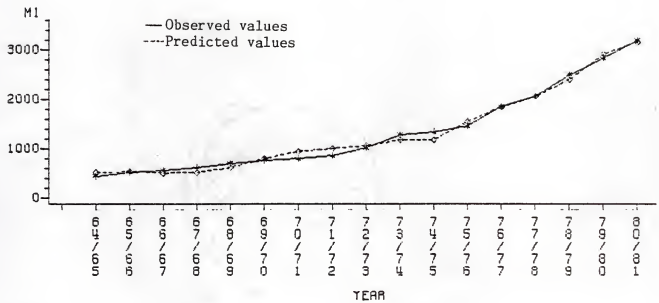

Figure 17. Simulation of money supply

"2SLS" method. If the critical value were set at 20%, the "RMS" percent errors of four equations, corresponding to MDVR, PAG, PNAG, and PGDP, lie well above the critical level. In the previous case of 2SLS, in only one case the "RMS" percent error crossed the 20% mark. If the critical value were to be set at 15%, then eight equations have the "RMS" percent errors higher than the critical level. The truncated 2SLS estimates had only two equations where the "RMS" percent errors exceeded the critical level at 15%.

This is not unusual that the "RMS" percentage error in the case of the 3SLS here was found greater than the 2SLS for each equation. There are two principal reasons for this. Firstly, the 3SLS as a "systems" or "full information" technique "requires a much more detailed specification of the equations than the 2SLS method does" [Theil, 1971:528] and makes use of restrictions on the structures of all other equations in the system to estimate the structure of each equation. Therefore, the estimator of each equation is rather sensitive to possible specification errors in all other equations in the system [Theil, 1971]. Secondly, the model is estimated on the basis of limited observations. And, it is doubtful how much confidence one could have on the comparison of alternate estimators of the equations (e.g., 2SLS vs 3SLS) on the basis of the "RMS" percent error because it is otherwise based upon "large sample theory."

Multiplier Analysis

The multipliers can be recognized as special cases of comparative static results corresponding to changes in each of the exogenous variables of the model (Intriligator, 1978:499). Multipliers are

derived from the reduced form of the model. The reduced-form equations represent a solution of the structural equations for the endogenous variables in terms of the exogenous (including predetermined) variables in the system. The multiplier of a macro model is typically described as $\frac{\partial Y}{\partial X}$, which indicates the rate of change in Y, an endogenous variable, with respect to X, an exogenous variable. An "impact multiplier" refers to the rate of change in the immediate value of an endogenous variable with respect to a change in a truly exogenous variable.

The interim, cumulative, and total multipliers of a model are obtained from the final form of the model. The final form represents a solution of the reduced-form equations for the endogenous variables in terms of current and lagged values of the truly exogenous variables, and present and lagged values of the reduced-form disturbances. The interim multiplier answers the question, "If an exogenous variable is raised by one unit for a period and then restored to its original level, what will happen to current and future values of an endogenous variable?" Interim multipliers for the current period are impact multipliers. Cumulative multipliers answer the question, "If an exogenous variable is raised by one unit in a period and then sustained at its new level, what will happen to current and future values of an endogenous variable?" Total multipliers are the same as cumulative multipliers as time approaches infinity (see Goldberger [1964] for further discussion of multipliers). The multiplier analysis of some selected variables of our primary interest are discussed in the following sections. We first take up multipliers for two exogenous variables, fertilizer consumption (FERT) and agricultural exports (XFR).

The effect of an increase in agricultural exports by Rs 1 million was to increase gross domestic product (GDPR) by Rs 1.06 million (Table 16). Similarly, an increase in agricultural exports by Rs 1 million had the affect of increasing GDPAGR by Rs 0.44 million, GDPNAGR by Rs 0.62 million, CPR by Rs 0.68 million, IGROSR by Rs 0.35 and total tax receipts (TXR) by Rs 0.20 million. The agricultural export (XFR) had significant effect on several of these variables. Its effect on the nonagricultural GDP (GDPNAGR) seemed to be substantial compared with its effect on the agricultural GDP (GDPAGR) itself.

Similarly, the use of fertilizers has significant effect on the variables GDPR, GDPAGR, GDPNAGR, CPR, IGROSR and TXR. Its effect is particularly significant on nonagricultural GDP, GDPNAGR. For instance, an increase in the consumption of fertilizer by one thousand tons has an impact of increasing GDPNAGR by Rs 0.05 million while it has an effect of an increase of only Rs 0.04 million in GDPAGR, the agricultural GDP.

It is interesting to note that an increase in XFR has only a contemporaneous impact on the agricultural GDP (GDPAGR), with no lagged multiplier effect. On the other hand, XFR has not only a impact multiplier, but also lagged multiplier effects on GDPNAGR, the nonagricultural GDP. This demonstrates the substantial effect of agricultual exports not only on the agricultural GDP but also on the nonagricultural sector, and through them, on the gross domestic product (GDPR) itself.

The impact multiplier of agricultural exports on total consumption (CPR) is 0.68, with a one-period lagged multiplier of 0.39 and total multiplier at 1.52. The impact multiplier and lagged multiplier

Table 16. Impact and lagged multipliers of fertilizer use and agricultural exports

	Impact multiplier		Interim multipliers for one period lag		Total multiplier	
	FERT	XFR	FERT	XFR	FERT	XFR
GDPR	0.09	1.06	0.14	0.17	0.11	1.39
GDPAGR	0.04	0.44	0	0	0.04	0.44
GDPNAGR	0.05	0.62	0.01	0.17	0.08	0.94
CPR	0.06	0.68	0.03	0.39	0.13	1.52
IGROSR	0.03	0.35	0.01	0.16	0.05	0.65
TXR	0.02	0.20	0.00	0.04	0.02	0.52

effects of the agricultural exports are present with respect to the gross investment (IGROSR) and total tax receipts (TXR) too.

The nature and extent of relationships of agricultural exports (XFR) and the consumption of fertilizer (FERT) indicate the relationships the agricultural sector and trade (here agricultural exports in particular) have on other sectors of the economy, e.g., the total gross domestic product, total consumption, gross investment and total taxes.

An increase in Rs 1 million in agricultural exports (XFR) results in an estimated increase of Rs 0.35 million in investment, IGROSR (Table 17). In other words, a 1% increase in XFR produces a 0.10% (a tenth of a percent increase in total investment (IGROSR)). Similarly, a 1% increase in the tax on imports (TXMR) produces a contemporaneous effect of 0.15% increase in IGROSR. On the other hand, a 1% increase in TXDR, the direct tax rate, leads to a similar effect of 0.24% increase in it. Thus, the elasticity of investment (IGROSR) with respect to direct tax rate (TXDR) is larger than the one corresponding to import tax rate, TXMR.

The elasticities of total tax receipt (TXR) itself with respect to TXMR and TXDR (import tax rate and direct tax rate) are 0.17 and 0.27, respectively. That is, a 1% increase in TXMR produces an increase of 0.17% in total tax revenue (TXR), while it is 0.27% in the case of a 1% increase in direct tax rate (TXDR). These elasticities are calculated from the multipliers and with variables at their mean values.

The elasticities of government development expenditure (GEXPDVR) with respect to TXMR and TXDR at their mean values are 0.13 and 0.21, respectively (Table 17). Clearly, the elasticity of GEXPDVR with

Table 17. Impact multipliers of EXSD1, TXMR, TXDR, XFR, and FERT

	EXSD1	TXMR	TXDR	XFR	FERT
IGROSR	-2.659 (0.045)*	6.108 (0.153)	52.901 (0.243)	0.345 (0.100)	0.029
MDVR	-1.044	2.397	20.761	0.135	0.011
MR	-9.369 (0.140)	-12.998 (0.291)	20.761 (0.081)	0.340	0.028
TXR	-1.535 (0.049)	3.526 (0.169)	30.539 (0.268)	0.199	0.017
GDPR	0	0	0	1.05941	0.088
GEXPDVR	-1.551 (0.039)	3.562 (0.133)	30.855 (0.211)	0.201	0.017

* Figures in parantheses represent elasticities at mean values.

respect to direct tax rate is estimated to be much higher than that for the import tax.

Policy Simulation

The final objective of an econometric model "and perhaps its most important potential use, is that of policy evaluation" [Intriligator, 1978:538]. Policy evaluation is, in many ways, closely related to forecasting. As such, policy evaluation is, in part, based upon forecasts of the effects of policy choices. Conversely, our interest in the policy simulation (or evaluation) could also be in determining how much change is necessary for a given policy variable, an exogenous variable, to effect a desired change in one or more of the endogenous variables. It is thus assumed that the exogenous variables of interest can be manipulated by the government.

Just as the forecasting use of an econometric model makes a distinction between short-term and long-term policies, "the policy evaluation use of the model also distinguishes between short-term and long-term policy" [Intriligator, 1978:538]. The short-term policy is concerned with stabilization of the economy within a short-term period, usually one or two years. Our primary interest in policy evaluation in the present study is concerned mainly with the short-term behavior of the economy. Hence, the exercises in policy evaluation here are related mainly to the estimated impact multipliers of the model.

In the following paragraphs, we consider how much changes are necessary in the policy variables in order to effect a given change in some of the endogenous variables. We first take up how much change is necessary in XFR, agricultural exports, in order to effect an increase

of Rs 10 million in total GDP, agricultural GDP, nonagricultural GDP, total consumption, total investment, total tax receipts, and government development expenditure (i.e., GDPR, GDPAGR, GDPNAGR, CPR, IGROSR, TXR and GEXPDVR, respectively). The necessary[2] extents of increase in XFR for given changes in these variables considered are given in Table 18.

In order to effect an increase of Rs 10 million in GDPR, the real gross domestic product, agricultural exports (XFR) need to be increased by an estimated Rs 9.43 million (Table 18).[3] In order to effect an increase of Rs 10 million in IGROSR, total investment, it would be necessary to increase XFR (agricultural exports) by Rs 28.57 million.

Policy simulations of GBDF2, the government budgetary deficit, and FAID, foreign aid, are given in Table 19. It could be seen that in order to effect an increase in money supply by Rs 10 million, other things remaining the same, the government budgetary deficit would need to be increased by Rs 11.9 million.

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[2]The word "necessary" is emphasized since we are interested in the movement required in a policy variable for given changes in some endogenous vriables.

[3]These levels of changes in policy variables are evaluated, keeping other variables constant.

Table 18. Necessary changes in agricultural exports (XFR) to effect a Rs 10 million increase in selected endogenous variables

Endogenous variables	Necessary changes in XFR
	-- million Rs --
GDPR	9.43
GDPAGR	22.73
GDPNAGR	16.13
CPR	14.71
IGROSR	28.57
TXR	50.00
GEXPDVR	50.00

Table 19. Necessary changes in government budgetary deficit (GBDF2) and foreign aid (FAID) to effect a Rs 10 million increase in money supply (M1)

	Necessary change in GBDF2	Necessary change in FAID
	million Rs	
M1	11.933	8.182

CHAPTER VII
SUMMARY AND CONCLUSIONS

This study has presented a macroeconomic model for the Nepalese economy. The empirical estimation of the model was done by the use of a truncated two stage least square estimation method of the simultaneous equations system. An alternate estimation of the model, based upon the systems method of three stage least squares, was also presented for comparison purposes.

The signs of the estimated parameters of the individual structual equations conformed, in general, to theoretical expectations. The levels of parameter estimates also seemed reasonable and rather consistent with results of similar studies.

In order to evaluate the model, a "within sample period" evaluation of the model was performed. In general, the model was able to track the actual course of events of the Nepalese economy over the period of study quite satisfactorily. Of 17 endogenous variables within the model, there was only one case (import of development goods (MDVR)) where the "Root Mean Square" percentage error was above an assumed critical level of 20%. In general, the model tracked not only the direction but also the levels of the corresponding variables.

The estimated model provides some important quantitative measures of the Nepalese economy. For instance, the marginal propensity to

consume[1] was estimated to be 0.64. This estimate seems quite reasonable with total consumption rather than private consumption in the consumption function. The elasticities of total tax revenue with respect to import tax and direct tax rates were estimated at 0.17 and 0.27, respectively. Similarly, the estimated elasticities of government development expenditure with respect to import tax and direct tax rates were found to be 0.13 and 0.21, respectively, at their mean values.

Several authors (e.g., Behrman [1974, 1975], Marwah [1969a, b], Evans [1969, 1970], and Klein [1968] have emphasize the need to incorporate a greater degree of disaggregation in macro models for developing countries than is usually done for developed countries. Disaggregation, in the present study, was extended in several aspects, e.g., GDP, into agricultural GDP and nonagricultural GDP; imports, into imports of consumption goods and development goods; tax revenue, into direct tax and indirect tax revenues; government expenditures, into development and regular expenditures; prices, into agricultural and nonagricultural prices; with separate behavioral equations to explain them. The model in the present study takes cognizance of the supply side as well rather than focusing only on the demand side as in many macroeconomic models for developed countries.

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[1]Because of lack of time series data on private consumption, consumption in the present model includes both government and private consumption. The marginal propensity to consume was calculated as a change in total consumption with a change in the gross domestic product because data on disposable income were lacking on time series basis.

Separate behavioral equations explain agricultural GDP and nonagricultural GDP (from the supply side).

The study was basically intended to address short-run behavior of the Nepalese economy. So, all the major results in the study were related to short-term issues. For example, the multiplier analysis and policy implications have focused on the short-run--largely with the use of impact multipliers. The results should provide some useful guidance to the policy-makers regarding the short-term behavior of some policy instruments.

The agricultural sector exerted a great deal of influence on the nonagricultural sector, and hence the entire economy, not only directly through the level of the agricultural GDP but also through the price mechanism. For instance, it was found that both agriculture GDP and agricultural price have considerable influence on the nonagricultural GDP and price.

Lack of data on a continuous time series basis prevented us from an extensive treatment of foreign trade. Yet it was possible to deal with it to some extent through imports which was disaggregated into imports of consumer goods and development goods with separate explanations of them. It was not possible to do so for exports because of a lack of time series data. As a consequence agricultural exports entered the model as an exogenous variable. Exports were found to have a good deal of influence on the Nepalese economy.

Building a macroeconomic of an economy should be viewed as an ongoing effort, especially for a developing economy like the Nepalese. Ways of improving a model always exist as our knowledge of key

relationships among different sectors and variables of an economy improves, including in a major way, improvements in available data.

Policy Implications

The problem of stabilization is a very important issue for "policy-makers" in the practical conduct of economic policies. In addition to traditional demand-related shocks, the increasing incidence of supply-induced shocks to the economy are important--especially for an economy, like that of Nepal. The Nepalese economy is heavily dependent on agriculture. And agriculture, in turn, depends mainly on variable monsoons. As a small country, the Nepalese economy is heavily exposed to foreign trade, not only for exports, but also imports. The smallness of the domestic market and the need to earn foreign exchange for imports of consumer and investment (development) goods are principal reasons for this exposure.

The model in this study captured the short-term issues of the Nepalese economy in an essential way. Therefore, the model could help in addressing stabilization issues. In particular, the model provides a basis for estimating the effect of such variables as the government budgetary deficit and exchange rate on variables endogenous to the economy such as agricultural GDP nonagricultural GDP, total consumption, and investments. As a consequence, the study could be expected to have important implications for the practical conduct of economic policies in Nepal.

The overall implication of the present study is that it provides an examination of the short-term behavior of the Nepalese economy

that should aid policy-makers in addressing stabilization issues. Specifically, the model provides a quantitative assessment of the effect of some general and sectoral economic policy variables on the economy.

Limitations of the Study and Implications for Further Research

Because of the present lack of time series data, the study was based upon a greater level of aggregation than what was intended initially. For instance, the consumption and the investment functions used data of total consumption expenditures and investment, respectively. Disaggregation into the private sector and the government sector (e.g., private consumption, private investment, and government investment) could have enabled a greater use of economic theories.[2]

Further, because of the lack of data presently, proxy variables had to be used. For instance, government investment had to be proxied by government development expenditures. A more complete treatment of the supply side of the agricultural sector would be possible with more reliable time series data on rainfall, irrigation, and sectoral prices.

[2]See Hansen [1973] for similar observation. Indeed, a problem in data constrainted his efforts to build a macroeconomic model for the Afgan economy. He adopted the Walrasian kind of model, with simple demand and supply equations for some commodities (this was possible because there were only few such commodities of any significance to the economy) without focusing on the more extensive macroeconomic relationships of the concerned sectors.

As a study of a short-term macroeconometric model of the Nepalese economy, this effort did not seek answers to long-term historical phenomena. Nevertheless, longer term issues are important--especially for planning in a country. In the present study, the lack of extensive data was the principal limitation to our effort to build a more comprehensive macroeconometric model for the Nepalese economy. First of all, there was a general dearth of time series data of various variables, e.g., those related with separate private and public consumption and especially price, with greater disaggregation. Even in the field of trade, where data were usually available with some relative ease, data on such variables as import prices, export prices, tariffs, and nontariff barriers were not available in any meaningful way. In many cases, it was possible to use only proxy variables.

It was not possible to incorporate several other important aspects of the economy, e.g., the income distribution. Lately, it has been popular to discuss poverty and income distribution in the economy of Nepal. It was not possible to address income distribution directly in the study. However, as the problem of poverty is inextricably linked to the problem of unemployment, full or "disguised," this study did touch upon distribution and poverty because the agricultural sector was the model's centerpiece. In this sense, the present study is in the spirit with the observation that "at the present stage of Nepal's development, it is inevitable to seek a solution of the problem of unemployment largely within the agricultural sector" [Islam et al., 1983:49].

Finally, it would but be appropriate to conclude with Evans' rather universally applicable remark about such efforts:

Virtually every econometric model description closes with a combination apology--that the model would still be improved by further work and that it may not be accurate for future exante predictions. It would be exhilarating to omit this statement just once, but it probably applies (here) more forcefully than in other cases. [1970:650]

APPENDICES

APPENDIX A
DATA AND DESCRIPTION OF VARIABLES

	Data	Sources
1.	Consumption Expenditure:	World Band [1980, 1983]; National Planning Commission [1980]
2.	Investment, Savings:	World Bank [1980, 1983]; National Planning Commission [1980]
3.	Imports (total, consumption goods, developing goods); Exports:	Nepal Rastra Bank [1981]; Ministry of Food and Agriculture [1972, 1977, 1978]
4.	Taxes (total, indirect, direct); Foreign Aid; Government Expenditures (development and regular); Tax Rates (direct, indirect, import); Government Budgetary Deficits:	Budget Speeches, Ministry of Finance, HMG/Nepal (several years); World Bank [1980, 1983]
5.	Gross Domestic Product (GDP); Agricultural GDP; Nonagricultural GDP:	MFA [1972, 1977, 1978]; World Bank [1980, 1983]
6.	Agricultural Price; Non-agricultural Price; GDP Deflator:	MFA [1968, 1972, 1977, 1978]; World Bank [1980, 1983]; IMF [1983]; United Nations [1979, 1980a]
7.	Money Supply; International Reserve; Exchange Rates:	Nepal Rastra Bank [1981]; World Bank [1983]
8.	Consumer Price Index; Import Price Index of India; Export Price Index of India; World GDP Deflator:	United Nations [1980b]; IMF [1983]
9.	Fertilizer Consumption	FAO [1981c]

Description of Variables:

Consumption:

Data on private consumption separately is not available on a time series basis. So, instead of using private consumption, total consumption (private consumption and government consumption) was used as the dependent variable in the consumption function.

Investment:

As in the case of consumption, time-series data for private investment are not available. Hence, instead of explaining only private investment, the present model seeks to explain investment (private plus government investment).

GDP (total agricultural and nonagricultural):

The GDP series, including its sectoral components--agricultural and nonagricultural were available in two series--(1) the "old series" (up to 1974-75), and (2) the new series (from 1974-75). The nominal GDP according to the "new series" is higher than that according to the "old series" for 1974-75.[1] For the present study, the nominal GDP for each year preceding 1974-75 was adjusted by the percentage by which the nominal GDP according to the "old series" is underestimated vis-a-vis the nominal GDP according to the "new series" for 1974-75.

Prices (agricultural, nonagricultural, and GDP deflator):

Derived by dividing nominal GDPs by the corresponding GDPs at constant prices for each year.

Consumer Price Index:

The consumer price index series is also available in two series--(1) the new series since 1966-67, and (2) the old series up to 1966-67 at which time the weights assigned to food and nonfood items were adjusted. The price index series for years before 1966-67 were adjusted in the present study by a percentage by which the price index in 1966-67 according to the new series deviates from the one according to the old series in the same year.

Foreign Aid at Constant Price:

While most variables, such as consumption, investment, imports, exports, and GDPs were deflated uniformly by the GDP deflator in order to arrive at their values at constant prices, foreign aid was deflated by world GDP deflator. The reason for this was that most foreign aid is available in foreign exchange, and it seems sensible that it be adjusted by a deflator such that it could reflect how much goods and services, including investment goods, a given amount of foreign aid would command in the world market.

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[1]This difference is probably due to changes in national accounts procedures and since 1974-75.

TABLE A-1. VALUES OF ENDOGENOUS VARIABLES USED.

OBS	YEAR	CPR	IGRDSR	MCR	MDVR	MR	TXIDRZ	TXDRZ	TXR
1	64/65	5931.00	360.80	556.000	262.900	818.90	93.500	57.800	151.300
2	65/66	5932.35	288.99	482.047	196.184	678.23	90.980	49.696	140.676
3	66/67	5661.14	294.38	261.786	181.400	443.19	143.370	64.549	207.919
4	67/68	5694.28	337.95	257.995	137.448	395.44	148.964	86.247	235.211
5	68/69	6152.41	300.70	393.779	184.992	581.57	206.687	79.705	286.392
6	69/70	6278.95	380.99	415.149	214.130	629.28	210.051	89.512	299.563
7	70/71	6197.00	494.15	325.410	173.590	499.00	201.927	80.443	282.370
8	71/72	6250.47	476.65	365.537	192.090	557.63	215.694	77.276	292.969
9	72/73	6373.08	609.26	424.051	231.379	655.43	268.954	78.215	347.169
10	73/74	6898.51	618.48	461.776	179.812	641.59	293.381	86.983	380.364
11	74/75	7422.59	724.14	456.282	397.647	853.93	314.259	82.682	396.941
12	75/76	7572.33	848.27	501.170	426.592	927.76	321.067	105.946	427.013
13	76/77	7557.64	1038.33	540.660	433.624	974.28	398.738	135.856	534.595
14	77/78	8085.31	1100.58	619.973	476.209	1096.18	425.788	127.918	553.706
15	78/79	7745.60	1594.19	684.544	479.540	1164.08	503.188	94.149	597.337
16	79/80	8009.90	1380.43	685.114	617.798	1304.91	480.465	94.563	575.028
17	80/81	8535.14	1291.57	733.355	674.658	1408.01	537.552	111.733	649.285

OBS	GEXPDVR	GEXPRGR	GDPAGR	GDPNAGR	GDPR	PAG	PNAG	PGDP	M1
1	231.900	117.000	4242.00	2232.00	6474.00	1.000	1.000	1.000	446.3
2	243.539	127.754	4027.41	2098.01	6925.41	1.174	1.106	1.153	521.5
3	246.561	157.090	4588.40	2233.89	6822.28	1.097	1.064	1.086	568.3
4	232.891	149.793	4696.77	2171.50	6868.27	1.241	1.140	1.207	618.3
5	267.652	150.078	4835.93	2339.81	7175.74	1.322	1.219	1.266	700.4
6	338.456	159.578	5007.28	2372.91	7380.19	1.412	1.298	1.373	763.3
7	331.906	217.345	5000.00	2373.30	7373.30	1.430	1.343	1.401	793.4
8	354.426	204.018	5178.91	2343.38	7522.28	1.672	1.443	1.593	857.7
9	405.463	249.300	5087.94	2537.61	7675.55	1.532	1.445	1.501	1015.8
10	414.606	261.886	5667.40	2496.97	8164.37	1.927	1.600	1.813	1291.1
11	455.153	257.224	5435.29	2362.82	7798.12	2.196	1.993	2.125	1337.7
12	560.009	315.777	5435.86	2707.40	8143.26	2.196	2.027	2.136	1450.5
13	726.977	403.736	5097.53	3286.75	8384.28	2.071	2.021	2.051	1852.9
14	802.486	384.776	5216.16	3541.94	8758.10	2.317	2.131	2.253	2060.6
15	798.547	420.379	5456.82	3508.07	8964.89	2.587	2.290	2.478	2504.9
16	865.617	435.733	5130.48	3625.05	8755.53	2.749	2.511	2.667	2830.4
17	868.426	432.750	5782.51	3461.69	9244.20	3.309	2.864	3.145	3208.0

TABLE A-2. VALUES OF EXOGENOUS VARIABLES USED.

OBS	CPRLAG	GDPRCHNG	P_PX_1	EXSD1	TXMR	TXDR	IGROSRLG	FA1DR	GEXPRGRL
1	5184.98	128.02	1.00000	7.620	8.8167	2.58961	671.38	141.000	124.266
2	5931.00	157.35	0.82446	7.620	10.2813	2.36875	360.80	166.619	117.000
3	5932.35	451.41	0.58301	8.030	22.4600	2.88953	288.99	129.763	127.754
4	5661.14	-103.13	0.73868	10.130	22.6273	3.97177	294.38	138.027	157.099
5	5694.28	45.98	0.72114	10.130	19.2396	3.40645	337.95	155.694	149.793
6	6152.41	307.47	0.72114	10.130	19.8843	3.77225	300.70	195.774	150.079
7	6278.95	204.45	0.75805	10.155	20.1974	3.38947	380.99	223.401	159.578
8	6197.00	-6.88	0.72343	10.993	19.2840	3.29762	494.15	192.862	217.345
9	6250.47	148.98	0.64800	12.518	22.0065	3.02266	476.65	141.724	204.019
10	6373.08	153.26	0.61042	12.700	22.3779	3.48354	609.26	149.471	249.300
11	6858.51	488.82	0.64266	13.359	15.9815	3.49930	618.43	152.963	261.886
12	7422.59	-366.25	0.58694	14.432	15.9711	3.91319	724.14	217.447	257.224
13	7572.33	345.14	0.54715	14.594	16.5886	4.13345	849.27	217.239	315.777
14	7557.64	241.02	0.60813	15.162	16.9859	3.61153	1038.33	303.609	403.736
15	8065.31	373.82	0.58153	15.804	15.8225	2.68377	1100.58	313.074	384.776
16	7745.60	206.79	0.58699	15.618	15.6369	2.60861	1594.19	363.575	420.379
17	8009.90	-209.36	0.67510	14.573	16.7833	3.22770	1380.43	371.069	435.733

OBS	FERT	PAGPNAGL	XFR	QAG	PMF_1	IRESV	GBDF2	FAID	PGDPW	P	PX_1
1	592	0.92731	258.900	1.000	1.000	56750	-157.5	141.0	1.00000	1.000	1.000
2	444	1.00000	159.584	0.961	1.571	47787	-211.6	175.0	1.05030	1.099	1.333
3	3416	1.06148	235.820	0.980	1.633	50275	-182.2	142.0	1.09430	0.899	1.542
4	2644	1.03102	167.274	1.019	1.633	61844	-136.0	158.0	1.14470	1.077	1.458
5	3022	1.08860	196.501	1.058	1.748	79731	-124.2	188.0	1.20750	1.112	1.542
6	4505	1.08450	215.878	1.088	1.586	91520	-217.2	252.0	1.28720	1.112	1.542
7	5359	1.08783	188.580	1.088	1.667	102261	-305.8	304.0	1.36690	1.200	1.583
8	8000	1.06478	176.271	1.044	2.143	110872	-334.8	281.0	1.45700	1.266	1.750
9	10270	1.15870	242.505	1.153	3.143	123541	-365.9	227.0	1.60170	1.377	2.125
10	12073	1.06021	213.514	1.164	3.905	131112	-441.3	277.0	1.85320	1.628	2.667
11	12656	1.20437	243.529	1.197	4.762	112568	-491.0	342.0	2.09864	1.901	2.958
12	12260	1.10186	376.404	1.175	4.667	120316	-781.5	506.0	2.32700	1.887	3.215
13	14865	1.08337	290.878	1.142	4.571	145331	-968.3	557.0	2.56400	1.938	3.542
14	16800	1.02474	179.893	1.175	5.190	140602	-1048.6	858.0	2.82600	2.154	3.542
15	18543	1.08728	197.256	1.088	6.571	175813	-1152.0	989.0	3.15900	2.229	3.833
16	20954	1.12569	114.923	1.207	7.580	186969	-1495.7	1340.5	3.68700	2.446	4.167
17	22600	1.09478	187.186	1.207	8.307	195800	-1586.9	1562.2	4.21000	2.774	4.109

TABLE A-3. PREDICTED VALUES OF ENDOGENOUS VARIABLES.

OBS	YEAR	CPRH	IGROSRH	MCRH	MDVRH	MRH	TXIDRZH	TXDRZH	TXRH
1	64/65	5724.94	387.11	596.072	255.819	851.89	148.503	62.032	210.535
2	65/66	5786.74	202.23	473.867	148.804	622.67	89.730	46.307	136.037
3	66/67	5977.65	298.08	262.262	139.022	401.28	152.543	61.006	213.549
4	67/68	5994.61	316.18	268.956	176.683	445.64	149.436	90.680	240.115
5	68/69	6053.88	318.36	331.698	174.056	505.79	149.679	74.249	223.929
6	69/70	6175.62	448.19	350.978	225.050	576.03	182.597	87.097	269.695
7	70/71	6297.88	516.23	378.309	258.996	637.30	207.548	79.411	286.959
8	71/72	6509.04	558.64	423.548	268.841	692.39	240.750	82.917	323.667
9	72/73	6791.73	633.55	405.643	283.433	689.08	291.298	76.840	368.139
10	73/74	7006.03	740.33	416.718	317.963	734.68	318.667	97.120	415.787
11	74/75	7197.73	824.79	550.071	357.438	907.51	329.643	94.446	424.089
12	75/76	7361.02	847.95	550.294	355.587	905.88	344.667	113.325	457.992
13	76/77	7523.14	996.15	556.259	405.936	962.20	374.670	122.953	497.623
14	77/78	7666.48	1111.34	586.108	463.114	1049.22	405.117	114.604	519.721
15	78/79	7878.83	1202.99	577.820	453.857	1071.68	452.808	91.558	544.365
16	79/80	8080.09	1268.50	676.935	520.643	1197.58	470.508	91.321	561.829
17	80/81	8323.49	1385.26	741.824	583.758	1325.58	527.213	114.641	641.854

OBS	GEXPDVRH	GEXPRGRH	GDPAGRH	GDPNAGRH	GDPRH	PAGH	PNAGH	PGDPH	MIH
1	290.954	143.054	4543.70	2448.60	6992.30	1.09864	1.04871	1.08007	513.98
2	181.351	105.970	4607.37	2133.79	6741.16	1.17224	1.10045	1.14553	534.72
3	219.492	140.563	4846.22	2152.13	6998.35	1.19549	1.12055	1.16761	503.96
4	263.545	163.302	4739.97	2161.58	6901.55	1.23650	1.15523	1.20623	529.91
5	255.810	159.526	4856.50	2126.74	6983.25	1.31149	1.21709	1.27637	622.88
6	315.742	184.124	4913.25	2221.24	7134.48	1.34142	1.24521	1.30563	792.91
7	361.646	199.389	4937.72	2308.62	7246.35	1.38569	1.28514	1.34828	947.60
8	399.146	223.326	4993.49	2502.68	7496.17	1.44320	1.33958	1.40466	1000.84
9	433.423	253.579	5252.59	2547.48	7800.07	1.74023	1.59027	1.68445	1058.40
10	495.447	287.052	5152.66	2798.92	7951.58	1.91564	1.74546	1.85233	1185.63
11	524.435	299.371	5413.37	2658.57	8111.95	2.10264	1.89519	2.02656	1173.45
12	589.558	321.070	5296.67	2945.96	8242.64	2.13485	1.93410	2.06017	1544.43
13	633.062	348.114	5325.73	3064.05	8389.78	2.14429	1.94577	2.07044	1849.79
14	706.538	366.631	5256.33	3252.14	8508.47	2.32920	2.10694	2.24652	2059.67
15	751.568	384.604	5425.51	3321.07	8746.59	2.57032	2.31147	2.47403	2407.66
16	800.272	398.455	5543.67	3379.39	8923.06	2.96495	2.64449	2.84574	2923.41
17	893.506	446.172	5581.90	3590.31	9172.21	3.14520	2.80246	3.01770	3164.33

APPENDIX B
TRUNCATED 3SLS ESTIMATES OF THE MODEL

Table B-1. Estimated equations under three stage least square method

1. CPR = -2388.09 + 1.142 GDPR + 0.05 CPRLAG
(685.02) (0.191) (0.159)

2. IGROSR = -27.462 + 1.584 GEXPDVR - 0.127 GDPRCHNG
(59.225) (0.108) (0.047)

3. MCR = -1535.24 + 0.260 GDPR + 684.697 P_PX_I
(168.176) (0.025) (76.584)

- 24.051 EXSD1 - 10.543 TXMR
(6.408) (1.477)

4. MDVR = 254.655 + 0.388 IGROSR - 309.475 P_PX_I
(83.497) (0.040) (101.214)

5. TXIDRZ = -917.824 + 0.145 GDPR + 0.050 MR + 1.672 TXMR
(46.117) (0.009) (0.027) (0.898)

6. TXDRZ = -68.670 + 0.030 GDPNAGR + 23.279 TXDR
(5.036) (0.001) (0.878)

7. GEXPDVR = -9.592 + 0.248 IGROSRLG + 0.106 FAIDR + 0.801 TXR
(25.147) (0.025) (0.105) (0.071)

8. GEXPRGR = 11.910 + 0.033 GEXPRGRL + 0.646 TXR
(14.742) (0.112) (0.083)

9. GDPAGR = 2943.17 + 0.053 FERT + 1516.28 PAGPNAGL - 0.002 XFR
(345.950) (0.007) (326.935) (0.213)

10. GDPNAGR = 1529.613 - 0.315 IGROSRLG - 7692.65 PAGPNAGL
(1355.571) (0.168) (1252.98)

+ 1.893 GDPAGR
(0.441)

11. PAG = -0.185 + 0.903 QAG - 0.0003 M1 + 0.381 PMF_I
(0.221) (0.210) (0.0005) (0.017)

12. PNAG = 0.204 + 0.832 PAG - 0.000021 GDPNAGR
(0.062) (0.024) (0.000026)

13. M1 = 107.971 + 0.004 IRESV - 0.551 GBDF2 + 0.991 FAID
(60.441) (0.0007) (0.134) (0.128)

Table B-2. Root Mean Square percentage error for equations in the model (3SLS)

Variable	"RMS" percentage error
CPR	11.943
IGROSR	32.138
MCR	12.323
MDVR	32.831
TXIDRZ	19.824
TXDRZ	10.802
GEXPDVR	23.503
GEXPRGR	21.396
GDPAGR	3.897
GDPNAGR	9.088
PAG_P	7.116
PNAG_P	4.492
M1	9.983
PGDP	100
MR	14.981
TXR	16.147
GDPR	2.501

BIBLIOGRAPHY

Ackley, G. 1961. Macroeconomic Theory. New York: Macmillan.

Ackley, Gardner. 1963. Un Modello Econometrics dello Sviluppo Italiano nel Dopoguerra. Rome: Gierfffre Editore.

Ali, M. M. B., G. Carrin, F. Bossier, and A. Lakhel. 1977. Design of Short-term Econometric Models for Developing Countries: The Case of Tunisia. Louvain, Belgium: Center for Operations Research & Econometrics.

Ando, A., and Frank Modigliani. 1963. "The 'Life Cycle' Hypothesis of Savings: Aggregate Implications and Tests," American Economic Review 53(1):55-84.

Behrman, J. 1974. "Modeling Stabilization Policy for LDCs in an International Setting." In A. Ando, R. Herring, and R. Marston (eds.), "International Aspects of Stabilization Policies." Proceedings of Conference, sponsored by the Federal Reserve Bank of Boston and the International Seminar of Public Economics.

Behrman, J. 1975. "Econometric Modeling of Income Determination in Latin America, with Special Reference to the Chilean Experience," Annals of Economic and Social Measurement 4/4(April):461-484.

Behrman, J. 1976. Foreign Trade Regimes and Economic Development. New York: NBER.

Behrman, J. 1977. Macroeconometric Policy in a Developing Country. Amsterdam: North-Holland Publishing Co.

Behrman, J., and L. R. Klein. 1970. "Econometric Growth Models for the Developing Economy." In W. A. Eltis, M. F. G. Scott, and J. N. Wolfe (eds.), Induction, Growth and Trade. London: Clarendon Press.

Beltran del Rio, A., and L. R. Klein. 1974. "Macroeconomic Model Building in Latin America: The Mexican Case," In N. Ruggles (ed.), The Role of the Computer in Economic and Social Research in Latin America. New York: Columbia University Press.

Bhagwati, J., and S. Chakrabarty. 1969. "Contributions to Indian Economic Analysis: A Survey," American Economic Review 59(4): Supplement.

Black, S. 1981. "The Impact of Changes in the World Economy on Stabilization Policies in the 1970's." In W. R. Cline and S. Weintraub (eds.), Economic Stabilization in Developing Countries. Washington, D.C.: Brookings Institution.

Brown, T. M. 1964. "A Forecast Determination of National Product, Employment and Price Level in Canada from an Econometric Model." In Models of Income Determination Studies in Income and Wealth. Princeton, N.J.: NBER:59-96.

Brundy, J., and Dale W. Jorgenson. 1971. "Efficient Estimation of Simultaneous Equations by Instrumental Variables," Review of Economics and Statistics 53(August):207-224.

Brundy, J., and Dale W. Jorgenson. 1974. "The Relative Efficiency of Instrumental Variables Estimators of Systems of Simultaneous Equations," Annals of Econometric and Social Measurement 3/4: 679-70.

Central Planning Bureau. 1961. Central Economic Plan, 1961, English edition. The Hague: Author.

Chenery, H., and A. M. Strout. 1966. "Foreign Assistance and Economic Development," American Economic Review 56:679-733.

Chichilinsky, G., and L. Taylor. 1981. "Agriculture and the Rest of the Economy: Macro Connections and Policy Restraints," AJAE 62(May):303-309.

Cline, W. R., and S. Weintraub. 1981. "Introduction and Overview." In W. R. Cline and S. Weintraub (eds.), Economic Stabilization in Developing Countries. Washington, D.C.: Brookings Institution.

Crockett, A. D. 1981. "Stabilization Policies in Developing Countries: Some Policy Considerations," IMF Staff Papers 28(1): 54-79.

Datta, M. 1964. "A Prototype Model of India's Foreign Sector," International Economic Review 5(January):82-103.

Dell, S., and R. Lawrence. 1980. The Balance of Payments Adjustment Process in Developing Countries. London: Pergamon Press.

Dusenbury, J. S. 1949. Income, Savings, and the Theory of Consumer Behavior. Cambridge, Mass: Harvard University Press.

Dusenbury, J. S., O. Eckstein, and G. Fromm. 1960. "A Simulation of the U.S. Economy in Recession," Econometrica 28(October):749-809.

Evans, M. 1969. Macroeconomic Activity: Theory, Forecasting and Control: An Econometric Approach. New York: Harper and Row Publishers.

Evans, M. 1970. "An Econometric Model of the Israeli Economy, 1952-1965," Econometrica 38(5):624-660.

FAO. 1981a. FAO Production Yearbook. Rome: Food and Agriculture Organization (including previous issues).

FAO. 1981b. FAO Trade Yearbook. Rome: Food and Agriculture Organization (including previous issues).

FAO. 1981c. FAO Fertilizer Yearbook. Rome: Food and Agriculture Organization (including previous issues).

Fisher, I. 1930. The Theory of Interest. New York: Macmillan.

Friedman, M. 1957. The Theory of the Consumption Function. Princeton, N.J.: Princeton University Press.

Fry, M. J. 1974. Resource Mobilization and Financial Development in Nepal. Kathmandu: Center for Economic Development and Administration and Nepal Rastra Bank.

Garcia, J. G. 1981. The Effects of Exchange Rates and Commercial Policy on Agricultural Incentives in Colombia: 1953-1978. Washington, D.C.: IFPRI.

Glower, C. J. 1982. "A Simple Macroeconomic Model of an Open and Underdeveloped Economy: El Salvador, 1960-76." Ph.D. dissertation, The American University, Washington, D.C.

Goldberger, A. S. 1964. Econometric Theory. New York: John Wiley and Sons, Inc.

Gordon, R. 1978. Macroeconomics. Boston: Little, Brown & Co.

Hansen, B. 1973. "Simulation of Fiscal, Monetary and Exchange Policy in a Primitive Economy: Afganistan." In H. C. Bos, H. Linneman, and P. de Wolff (eds.), Economic Structure and Development. Amsterdam: North-Holland Publishing Co.

Hayami, Y., and V. W. Ruttan. 1971. Agricultural Development: An International Perspective. Baltimore: The Johns Hopkins Press.

Hirshleifer, J. 1958. "On the Theory of Optimal Investment Decision," Journal of Political Economy 66(August):329-352.

Ichimura, S., L. R. Klein, S. Koizumi, K. Sato, and Y. Shinkai. 1964. "A Quarterly Econometric Model of Japan, 1952-59," Osaka Economic Papers 12(March):19-44.

IFAD. 1979. Report of the Programming Mission. Rome: International Fund for Agricultural Development.

IMF. 1981. International Financial Statistics: Price Supplement. Washington, D.C.: International Monetary Fund (including several previous issues).

IMF. 1983. International Financial Statistics. Washington, D.C.: International Monetary Fund (including several previous issues).

Intriligator, M. 1978. Econometric Models, Techniques and Applications. Englewood Cliffs, N.J.: Prentice-Hall, Inc.

Islam, N. 1965. A Short-term Model for Pakistan Economy. London: Oxford University Press, Pakistan Branch.

Islam, R., A. R. Khan, and E. Lee. 1983. Employment and Development in Nepal. Bangkok: ILO, Asian Regional Team for Employment Promotion.

Johnson, H. 1967. Economic Policies towards Less Developed Countries. Washington, D.C.: Brookings Institution.

Johnston, B. 1970. "Agriculture and Structural Transformation in Developing Countries: A Survey of Research," Journal of Economic Literature 8(2):369-404.

Johnston, B., and J. Mellor. 1961. "The Role of Agriculture in Economic Development," American Economic Review 51(September): 566-595.

Keynes, J. M. 1936. The General Theory of Employment, Interest and Money. New York: Harcourt Bruce.

Khan, M. S., and M. D. Knight. 1981. "Stabilization Programs in Developing Countries: Formal Framework," IMF Staff Papers 28(1):1-53.

Klein, L. R. 1968. "What Kind of Macroeconometric Models for Developing Economics." In A. Zellner (ed.), Readings in Economic Statistics and Econometrics. Boston: Little, Brown and Co., pp. 559-570.

Klein, L. R., R. J. Bell, A. Hazlewood, and P. Vandome. 1961. An Econometric Model of the United Kingdom. Oxford: Basil Blackwell.

Klein, L., and A. Goldberger. 1955. An Econometric Model of the United States, 1929-1952. Amsterdam: North-Holland Publishing Co.

Klein, L. R., and Y. Shinkai. 1963. "An Econometric Model of Japan, 1930-57," International Economic Review 4(January):1-28.

Kmenta, J. 1964. "Australia Post War Immigration: An Econometric Study," Econometrica 32:114-241 (Abstract).

Krishna Murti, K. 1964. "An Econometric Model for India, 1948-61." Ph.D. dissertation, University of Pennsylvania.

Kuznets, S. 1942. Users of National Income in Peace and War. New York: NBER, pp. 1-37.

Lipton, M. 1977. Why Poor People Stay Poor: Urban Bias in World Development. London: Temple Smith.

Mahalanobis, P. C. 1953. "Some Observations on the Process of Growth of National Income," Sankhya 12:307-312.

Mammen, T. 1967. "An Econometric Study of Money Markets in India." Ph.D. dissertation, University of Pennsylvania.

Marwah, K. 1964. "An Econometric Model for Price Behavior in India." Ph.D. dissertation, University of Pennsylvania.

Marwah, K. 1969a. "An Economic Model for Colombia: A Prototype Devaluation View," Econometrica 37(2):228-251.

Marwah, K. 1969b. "An Econometric Model of India, Estimating Prices, Their Role and Source of Chance." Mimeo.

McCarty, F. D., and L. Taylor. 1980. "Macro Food Policy Planning: A General Equilibrium Model for Pakistan," Review of Economics and Statistics 62(1):107-121.

Mellor, J. W. 1982. "Foreword" In C. Rangarajan (ed.), Agricultural Growth and Industrial Development, Washington, D.C.: International Food Policy Research Institute.

Modigliani, F. 1977. "The Monetarist Controversy or, Should We Forsake Stabilization Policies?" American Economic Review 67(2): 1-19.

McKinnon, R. I. 1964. Foreign Exchange Constraints in Economic Development and Efficient Aid Allocation, Economic Journal 74: 388-409.

Ministry of Food and Agriculture, HMG. 1978. Agricultural Statistics of Nepal. Kathmandu, Nepal: Author (including previous issues).

Narasimham, N. V. A. 1956. A Short-term Planning Model for India. Amsterdam: North-Holland Publishing Co.

National Planning Commission. 1980. Sixth Plan. Kathmandu, Nepal: Author.

Nepal Rastra Bank. 1981. Quarterly Economic Bulletin, Vol. 16(1). Kathmandu, Nepal: Author (including previous issues).

Nerlove, Marc. 1966. "A Tabular Survey of Econometric Models," International Economics Review 7(2):127-175.

Nicholls, J. 1963. "The Agricultural 'Surplus' as a Factor in Economic Development," Journal of Political Economy 71(1):1-29.

Norton, R. D., and S. Y. Rhee. 1981. "A Macroeconometric Model of Inflation and Growth in South Korea." In W. R. Cline and R. Weintraub (eds.), Economic Stabilization in Developing Countries. Washington, D.C.: Brookings Institute.

Nugent, J. G. 1975. "Policy-Oriented Macroeconometric Models for Development and Planning. Annals of Economic and Social Measurement 4/4(April):509-529.

Pani, P. K. 1977. A Macroeconomic Model of the Indian Economy. Delhi: The Macmillan Co. of India Ltd.

Patinkin, D. 1965. Money, Interest and Prices, 2nd ed. New York: Harper & Row.

Prachowny, M. F. J. 1975. Small Open Economies. Lexington, Mass.: D. C. Heath and Company.

Quezada-Salcedo, N. 1981. "Endogenous Agricultural Price and Trade Policy in the Dominican Republic." Ph.D. dissertation, Purdue University.

Rangarajan, C. 1982. Agricultural Growth and Industrial Development. Washington, D.C.: International Food Policy Research Institute.

Rhomberg, R. R. 1964. "A Model of the Canadian Economy under Fixed and Fluctuating Exchange Rates," Journal of Political Economy 72(February):1-31.

Schuh, G. E. 1968. "Effects of Some General Economic Development Policies in Agricultural Development," AJAE 30(5):1283-1293.

Schuh, G. E. 1975. "General Economic Policy as a Constraint to the Development of Agriculture." Presented at Seminar on Agricultural Policy, Inter-American Development Bank, Washington, D.C., March 17-21.

Schuh, G. E. 1981. "The Foreign Trade Linkages." The Federal Reserve Bank of Kansas City, sponsored symposium Modeling Agriculture for Policy Analysis, September 24-25.

Shah, S. D. 1981. "Developing an Economy--Nepal's Experience," Asian Survey 21(10):1060-1079.

Shrestha, O. L. 1975. "Some Aspects of Landlocked Nepal's Trade Relations with India: 1960/61-1969/70." Ph.D. dissertation, University of Hawaii.

Stephenson, J. A., and K. Itharattana. 1977. Macroeconometric Analysis of Economic Activity in Thailand, 1962-74. Ames, Iowa: Iowa State University, DAE-CARD Sector Analysis Series, No. 3, (March).

Suits, D. B. 1962. "Forecasting and Analysis with an Econometric Model," American Economic Review 52(March):104-132.

Suits, D. B. 1964. An Econometric Model of the Greek Economy. Athens: Center of Economic Research.

Taylor, L. 1979. Macro Models for Developing Countries. New York: McGraw-Hill Book Company.

Taylor, L. 1983. Structural Macroeconometrics. New York: Basic Books, Inc.

Thorbecke, E., and A. Field. 1969. "Relationships between Agriculture, Nonagriculture and Foreign Trade in the Development of Argentina and Peru." In E. Thorbeck (ed.), The Role of Agriculture in Economic Development. New York: NBER.

Theil, Henri. 1971. Principles of Econometrics. New York: John Wiley and Sons, Inc.

Theil, Henri. 1982. "The Maximum Entropy Distribution," Discussion Paper 59, University of Florida, College of Business Administration, Gainesville.

Timmer, C. P., W. P. Falcon, and S. R. Pearson. 1983. Food Policy Analysis. Baltimore: The Johns Hopkins University Press.

Tinbergen, J. 1939. "Business Cycles in the United States of America, 1919-1932, Part II." In Statistical Testing of Business Cycle Theories. Geneva: League of Nations.

Tinbergen, J. 1951. Business Cycles in the United Kingdom, 1870-1914. Amsterdam: North-Holland Publishing Co.

United Nations. 1980a. Yearbook of National Account Statistics, Vol. 1, Part 2. New York: Author (including previous issues).

United Nations. 1980b. Statistical Yearbook of Asia and the Pacific. New York: Author (including previous issues).

UNCTAD. 1968. "Trade Projection for India." In Trade Prospects and Capital Needs of Developing Countries. New York: Author.

Valvanis, S. 1965. "An Econometric Model of Growth: U.S.A., 1869-1953," American Economic Review, Papers and Proceedings 45 (May):208-221.

Wicksell, K. 1936. Interest and Prices. London: Macmillian (Translated by R. F. Kahn from Geldzins and Guterpreise).

Wong, K. 1974. "A Macroeconomic Model of Singapore, 1960-1969," Malayan Economic Review 19(April):40.

World Bank. 1976. Review of Economic Situation of Nepal, Report No. 1180-NEP. Washington, D.C.: Author.

World Bank. 1979a. Nepal: Agricultural Sector Review, Report No. 2692-NEP. Washington, D.C.: Author.

World Bank. 1979b. Nepal: Development Prospect and Retrospect, Report No. 2692-NEP. Washington, D.C.: Author.

World Bank. 1980. World Tables. Washington, D.C.: Author (including previous issues).

World Bank. 1983. Nepal Recent Developments and Selected Issues in Trade Promotion, Report No. 4663-NEP. Washington, D.C.: Author.

Zarembka, P. 1967. "A Long-run Economic Growth Model for Under-developed Countries." Ph.D. dissertation, University of Wisconsin.

Zarembka, P. 1972. "A Long-run Economic Growth Model for Developing Countries." In L. E. de Marco (ed.), International Economics and Development: Essays in Honor of Raul Presioch New York: Academic Press.

BIOGRAPHICAL SKETCH

Durgesh M. Singh Shrestha was born in Kathmandu, Nepal, on March 15, 1947. He completed his high school in 1962 with distinction in the School Leaving Certificate examination. He topped the list of Tribhuvan University, Kathmandu, in the Intermediate of Arts examination of 1964 and the Bachelor of Arts examination of 1966 with distinction in mathematics. He entered the Delhi School of Economics, University of Delhi, for Master of Arts in economics, beginning the academic year 1966-67. He held the Delhi School of Economics Merit Scholarship and graduated in 1968-69.

In 1971, he attended courses on export promotion in the International Trade Center, GATT, UNCTAD, in Geneva, Switzerland. In the course of survey works, he travelled in England, France, West Germany, Sweden, Italy, Australia, Hong Kong, and Thailand.

He taught economics at Padma Kanya College, Kathmandu, and Department of Economics, Tribhuvan University, Kirtipur. He also taught Development Planning in the Institute of Business and Public Administration, Tribhuvan University.

He joined the Center for Economic Development and Administration, Tribhuvan University, in 1974 as Senior Research Officer. Besides involvement in research and seminars, he lectured on development planning and project analysis in the Seminar-cum-Workshops on Development Planning, and Project Analysis and Management, organized

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He served as a member of the National Price Commission, His Majesty's Government of Nepal. He also served in the Task Force for Sectoral Coordination and Overall Growth for the Sixth Plan, Ministry of Food and Agriculture, and National Planning Commission, His Majesty's Government of Nepal.

He joined Agricultural Projects Services Center, Kathmandu, as Senior Economist in 1978 with involvement in research, seminars and project formulation and feasibility studies.

In September, 1980, the Agricultural Development Council awarded him a scholarship to pursue a Ph.D. degree with a major in food and resource economics and a special field in economic development at the University of Florida.

Prior to this, he attended the American Economics Association-sponsored Economic Insitute's Summer Program at the University of Colorado, Boulder, from June 15 to August 1980, also with the Council's support. He is currently a member of the American Economic Association and Gamma Sigma Delta, the Honor Society of Agriculture.

He is married to Meera and blessed with a son, Anish, and daughter, Aniva.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Emilio Pagoulatos, Chairman
Professor of Food & Resource Economics

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